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A Monthly Popular Journal of Knowledge

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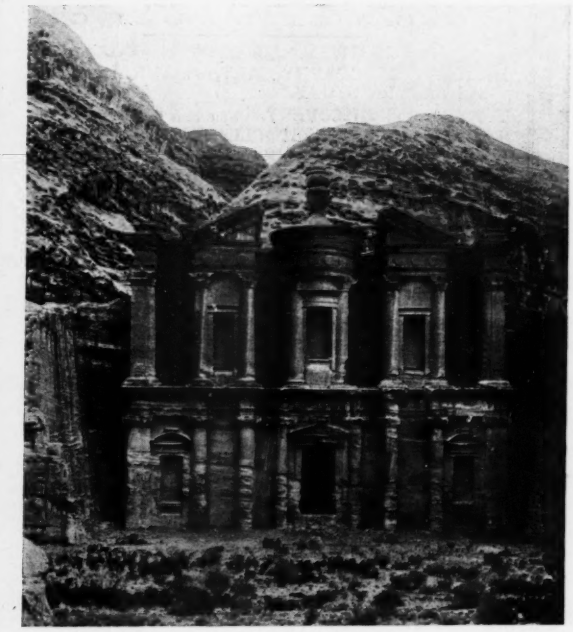

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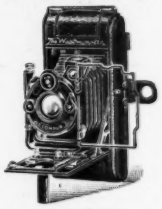

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Editorial Notes.

London snow has always had a reputation for dinginess, but it is probably little worse than the dirty snow of any great coal-consuming city. It does, however, bring home to the individual the astoundingly dirty condition of our atmosphere. If it lies a day or two a film of smuts and dirt is deposited on the surface, and even in a day a critical observer will see the change from pure white to a faint grey. Smoke pollution is an enormously costly business. It is a continual expense not only to the community but to the individual. Yet public opinion is slow to realize that if sufficient pressure is brought to bear it is an evil which can be enormously abated and eventually abolished. One visualizes the smoke evil as a vast factory shaft belching out great clouds of coal smoke. If you protest to someone who is supposed to know about the mechanism of local self-government, he replies "It is not the factories. It is millions of little coal fires all over the place. You can't do anything." This sounds convincing, but is it really so? I know that if I look from a high hill in the Midlands I can see two towns of nearly equal size. One is a small industrial town, the other still mainly agricultural. Over the factory town hangs its own poison mantle. The other town, where there are just as many domestic fires, shines clear and clean.

* * * * *

It is curious that a nation bitter against the use of poison gas in warfare is content to live in a cloud of it during peace. Every medical man now realizes the importance of sunlight as a health factor. It is carefully considered in housing schemes. Material substitutes for glass which will permit more of the health-giving ultra-violet radiations to pass are being sought for use in schools. Yet the very local authorities who are insisting on these wise provisions do nothing to check the local manufacturer whose smoke stack fouls the sky. It is even possible that the local authority's own generating station may be an outstanding offender. There are societies interested in smoke abatement who send out pamphlets waking our lazy consciences to the stupidity of letting pollution go on. It is good work, but it is not half enough. Not one of the pamphlets I have seen tells me what I want to know and what everyone who grumbles about the present conditions wants to know. What powers can be invoked to force an air-poisoning factory to muzzle its chimney? The nearest policeman can deal summarily with far less important nuisances, yet who can compel some company with a giant chimney stack to stop it smoking? The argument that a tall stack carries the smoke so high that it is not a nuisance is not much use. The smoke has to go somewhere, and the sulphur of London not only blights Kew but attacks the limestone of Windsor Castle. The effect of smoke pollution and fog on vegetation has also been worked out and has been shown to be a serious source of damage not only to the miserable plant life of towns but to distant country. The fogs not only choke the breathing pores of the leaves and poison them, but the acid products carried down in rain kill off the soil bacteria and produce an acid soil affecting the quality of the grazing. Smoke pollution affects plant, man and beast. The annual cost of painting, papering, and washing must be prodigious, yet unseen interests appear to control the situation. We look at a skyscape of chimneys and perhaps single out the worst offenders. We do not as a rule know who they belong to or what particular concern profits from their neglect of communal decency. There is no mention of smoke abatement

in even the most optimistic election literature, although a "clean air" candidate should command the vote of every woman except the laundresses. Gas and electricity may in the end vanquish some of the trouble, but no one can live in London without a sincere convicton that either immediate legislation is required or that if legislation exists it is high time that it was put into ruthless operation.

* * * * *

Three or four more expeditions have been announced in the papers as about to leave on scientific or archaeological trips. Frankly, these matters are being overdone so far as preliminary publicity is concerned. The joys of publicity are undeniable, and for a time publicity may be profitable. It helps the sale of books and adds cubits to the importance, but sometimes it hits back. A pure adventurer who has not satisfactorily explained to anybody what he was doing during the years of the Great War when manhood was in arms, appears with extremely fishy stories of his adventures in Atlantis or darkest Gondwanaland, and presents the British Museum with a bag of ethnological trifles. He writes, lectures, and is made much of. Little by little he becomes identified in the public mind with scientific research in anthropology, zoology, and exploration, and is accepted as a genuine authority. The shipping lines that go to Atlantis or carry goods to Gondwanaland know all about our mythical adventurer. They know him as a free-tongued untrammelled liar of outstanding impudence. They know where he got his trophies and how he got them. Gradually their knowledge filters through and the lay world gets a poor opinion of the credulity of scientists in general. Serious work is overshadowed by the notoriety-seekers and a doubtful personality discredits the whole field. Travel and exploration expeditions are becoming more than a little suspect, and the bogus explorer is a public nuisance. A wild-animal collector returned from somewhere back of the Amazon country gave me a delightful description of suburban jungles not too far from a town where nominal explorers passed a happy time camping until a decent time had expired for the expeditions to return to the United States or Europe and tell the tale of their hardihood and their ventures. This man's life has been passed in the wildest parts of the world, he knows his job thoroughly, and has only been back to England about four times in twenty years. If you refer to him as an explorer he is insulted.

* * * * *

The recent weather has produced the usual crop of queries about weather cycles, the effect of sunspots, and the possibility of forecasting hard winters. It is a subject of great interest, but I have not yet been able to find anybody with a serious reputation as a meteorologist who would admit that any claim for cycles of cold or hot weather could be scientifically maintained. Opinion on sunspot effects was divided, but the preponderance of opinion was that although they produced magnetic disturbances, it had not yet been proved that they affected the weather. Sunspots are quite common things, but that we only notice them when it is particularly bad weather seems to be the real basis of the theory. Observations must be continued for many years before the theory can be deemed to be proved, and as someone cold-bloodedly pointed out, if it were really sound the weather ought to be upset everywhere, not simply over Western Europe.

BRITISH ASSOCIATION.

For the meeting of the British Association in Oxford, 4th to 11th August, under the presidency of the Prince of Wales, the Council have appointed the following sectional presidents:—Section A (Mathematics and Physics), Dr. A. Fowler, F.R.S., Professor of Astrophysics in the Imperial College of Science and Technology; Section B (Chemistry), Dr. J. F. Thorpe, C.B.E., F.R.S., Professor of Organic Chemistry in the Imperial College of Science and Technology; Section C (Geology), Dr. S. H. Reynolds, Professor of Geology in the University of Bristol; Section D (Zoology), Dr. J. Graham Kerr, F.R.S., Regius Professor of Zoology in the University of Glasgow; Section E (Geography), the Hon. W. Ormsby-Gore, M.P., Colonial Office; Section F (Economics), Sir Josiah Stamp; Section H (Anthropology), Dr. J. H. Fleure, Professor of Geography and Anthropology in University College, Aberystwyth; Section I (Physiology), Dr. J. B. Leathes, F.R.S., Professor of Physiology in the University of Sheffield; Section J (Psychology), Dr. J. Drever, Reader in Psychology in the University of Edinburgh; Section K (Botany), Professor W. Bateson, F.R.S., Director of the John Innes Horticultural Institution; Section L (Education), Sir T. H. Holland, K.C.S.I., F.R.S., Rector of the Imperial College of Science and Technology; Section M (Agriculture), Sir Daniel Hall, K.C.B., F.R.S., Chief Scientific Adviser to the Ministry of Agriculture. The name of the president of the Engineering Section will be announced later.

Petra.

By Harold J. Shepstone, F.R.G.S.

A few short years ago Petra was unknown to the world—a lost city of the desert. To-day the tourist can reach Petra by railroad and the ubiquitous Ford car. Yet we have still to learn the history of the events that led to the abandonment of the city.

UNIQUE among the many wonders of the Orient and the remains of hoary civilizations, stands Petra, the rock-hewn city, the city so graphically addressed by the prophet as "Thou that dwellest in the clefts of the rock, whose habitation is high" (Obad. iii), and referred to in the challenge of the Psalmist (lx, 9), "Who will bring me into the strong city? Who will lead me into Edom?" It lies on the north-west edge of the great Arabian desert about midway between the Gulf of Akabah and the Dead Sea. Other ruins, such as Palmyra and Baalbec, show crumbling piles of magnificent architectural monuments, but in Petra, high up among the mountain crags that sentinel it, are temples, theatres, tombs, and other structures, strong and indestructible, standing almost as perfect as when they were chiselled out of the living rock of which they still form a part.

PANORAMA OF TOMBS ON THE EAST ROCK FACE.

These ruins (if ruins they may be called), challenge admiration by the variety of styles they embody—showing, in the most ancient creations, early native art intermixed with Egyptian, and in the later magnificent edifices the best types of Greek and Roman architecture—and by the exquisite hues of the sandstone from which they were hewn, varying from the prevailing purplish-red of the mountains and cliffs to the delicate pink and rose colour of some strata and the white, crimson, yellow and blue ribboned veins in other places, rivalling the softness of the plumage of birds or the petals of flowers.

Petra, so long inaccessible because of its remoteness and the danger from roving Bedouins, can now be reached with comparative ease by means of the Damascus-Mecca railway. One travels down from Jerusalem by motor-car to the Jordan and hence by the new Allenby bridge to Amman, the capital of Trans-jordania. Here, on two days a week, train may be taken to Maan, 120 miles distant, which is reached in eight to ten hours. From this point camels or horses can be hired and the ruins reached in about another six hours.

Now that this section of the country is more settled the ruins are expected to attract the attention of archaeologists and explorers in the near future. The fact is, we have much to learn concerning this ancient city with its 850 temples, monuments and tombs. Although its existence was known in the early eighties, it is only during the last twenty-five years that anything like a scientific examination of the city and its monuments, and the story which they have to tell, has been undertaken. One of the last

experts to make a systematic survey of the ruins was Sir Alexander Kennedy.

It is a stiff climb upwards from Maan, for Petra lies high among the mountains, right in the shadow of Mount Hor, called by the natives Jebel Harum (Aaron), from the tradition that it was here on the top of the mountain that Aaron died. The ruins are approached through a narrow gorge, called the "Sik." The rocks of this ravine rise from two to five hundred feet, sometimes like a sheer wall on the right hand and left, and are in places only fifteen feet apart. After traversing this gorge for a couple of miles one enters a valley, the site of ancient Petra, and a strange spectacle greets the eye. All around, cut out of the mountain sides, are wonderful edifices, many of them adorned with beautiful columns and pillars.

One Gate.

This valley, situated among the hills, is about three-quarters of a mile long, varying in width from five hundred yards at one end to half that distance at the other. The rocks rise up almost perpendicularly around it, and in ancient times there was only one approach—namely, through the Sik. Thus protected by mountains and precipices on every side, this remarkable town lay secure from attack from without. It was its impregnable position and its being on the great caravan route to the Red Sea from the north, that gave it the importance it had as a trade depot and stopping place.

ONE OF PETRA'S MANY TOMBS.

Just where the gorge widens out stands the magnificent ruins of the Khaznet el Faroun, or Treasury of Pharaoh, justly regarded as one of the wonders of the East. It is, however, one of the latest of the rock-hewn monuments of Petra, being attributed to the Emperor Hadrian who visited the place in A.D. 131, and erected here a temple to Isis. The cliff from which it is cut is an exquisite rose-pink in colour, and the edifice is in a wonderful state of preservation. The imposing façade has two rows of six majestic columns, one row above the other, with niches in which are rock-hewn equestrian and other statues, the whole terminating above in a miniature temple, crowned by a huge urn, which the Arabs declare contains the treasures of Pharaoh. The structure has a total height of about seventy feet. A richly-decorated door leads from the portico into a principal room, about a hundred feet square, but devoid of ornamentation. There are three smaller chambers adjoining.

A short distance beyond one emerges into the mountain-guarded valley in which the city lay, mounds of debris marking the sites of the former homes of the Petrans. The rock-hewn structures seen cut into the precipitous cliffs on every side were public buildings and tombs rather than dwellings. Just on the left, as the valley is entered, is the vast rock-cut theatre in semi-circular form, capable of holding three thousand spectators. Here the workmanship is Greek. There are thirty-three tiers of seats. In this locality are some of the oldest tombs, including many detached pylons. Many of the oldest tombs were cut away when the theatre was hewn out of the mountain side.

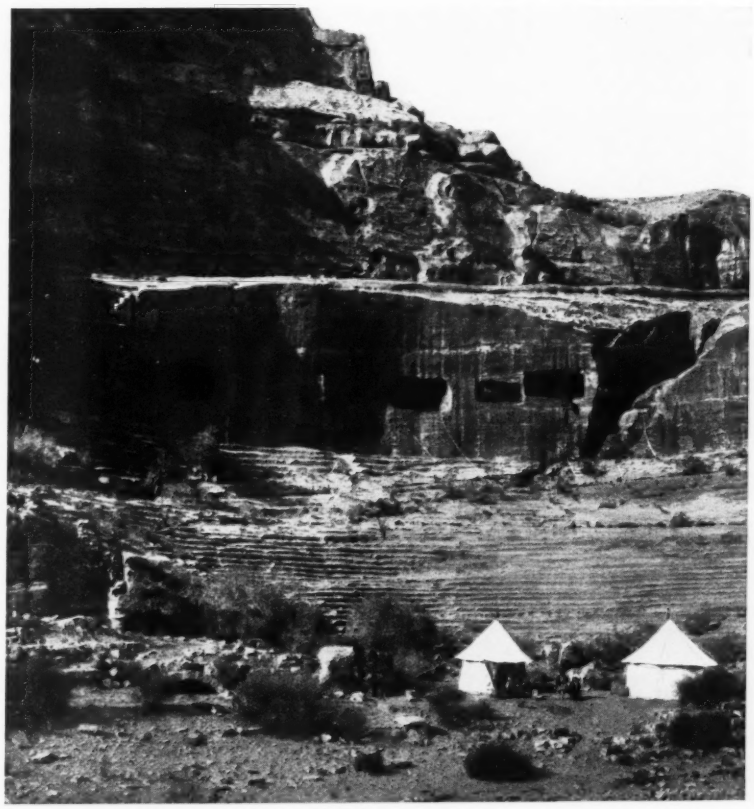
Standing in this small open valley one sees the façades of tombs and temples of many styles and dimensions, with many niches for votive offerings. They are at all elevations, many low down on the mountain side, and others high up in the cliffs with stairways cut in the rock to reach them. While most of them stand out conspicuously, others are hidden in the mountain recesses and lateral valleys.

Castle of Pharaoh.

A rock-hewn stairway of many hundreds of steps brings one to the largest of Petra's ruins, the El Deir, or convent. In design it somewhat resembles the Treasury of Pharaoh. It is nearly a hundred and fifty feet high, and almost as long, having a double

row of six columns each, adorned with corner pilasters. Natives declare that in the dead of night the growls of hyenas and other wild beasts may be heard within its mysterious chambers. Then, on the west side of the valley, we have another wonderful ruin, known as Kasr Farioun, or the Castle of Pharaoh. It was undoubtedly used as a temple, as it contains an altar.

Behind the Kasr Farioun a rock-cut staircase leads up the rugged Hill of the Acropolis to the Place of Sacrifice with its altars, pool, and court, all hewn out of the living rock, giving a good idea of the holy places or "high places" of the primitive peoples of the land, and which were the subjects of so many warnings to the Children of Israel. There are other high places in the vicinity of Petra. Indeed, it was not until Petra was explored that the meaning of the oft-repeated Bible reference to the "high place" was understood.



THE GREEK THEATRE AT PETRA HEWN OUT OF THE ROCKS.

Graves.

Of tombs, no fewer than eight hundred have been located, all hewn out of the solid rock, and many adorned with magnificent monuments. Sir Alexander Kennedy discovered several new ones, and there is no doubt that a systematic and exhaustive search would reveal others. Some of these tombs were built by the warlike Nabataeans, and others by the Romans and Greeks. These latter are decidedly the more interesting, being in some instances very massive and elaborate affairs. There are, for instance, the Tomb with the Urn, the Corinthian Tomb, the Tomb with the Three Stories, the Tomb of the Governor, and a host of others. The first-named is a two-storied structure containing ten vaults, now empty. These chambers, the largest of which is sixty feet square, are filled with tomb niches. TheTomb of the Governor marks the resting-place of Sextus Florentinus, one of the Roman governors of Petra. It has the appearance more of a temple than a tomb, being embellished with columns and pilasters and adorned with figures, the whole capped by an eagle with extended wings. It is undoubtedly one of the grandest sepulchral monuments of this remarkable city. As you stroll among these empty tombs, high up among the mountains, you think of the diverse peoples they have looked down upon, and how many different religions have been represented by ministering priests at these shrines.

Water Supply.

Down through this valley there once flowed a river, though it is now dry. You can still see where it was bridged, and here and there the roadway that fringed it widened by cutting away the foot of the rock. The ingenuity and indefatigable energy of the dwellers of this ancient city are well shown in the huge tunnel they cut through the mountain, at the opening of the Sik, or gorge, whereby they could in winter divert to the other side of their mountain the raging waters of the torrent, which has since that day brought down boulders weighing many tons. This tunnel was sixteen and a half feet broad, nineteen and a half feet high, and three hundred and thirty feet long. Then one can trace the course of the aqueducts which brought the drinking water into the city, as well as

the grand arch or portal thrown across the entrance. It was erected for decorative effect, and the niches underneath contained statues and carved images.

The People of Edom.

Who were the people who dwelt in this wonderful rock city, and why did they desert it? In its palmy days Petra is estimated to have had a population of from forty to eighty thousand. Its early history is hidden in the mists of antiquity, but it was probably the capital of Edom. Its first mention is in sacred history, in the Book of Kings, which records its conquest by Amaziah in the ninth century B.C. From Isaiah we learn that about 700 B.C. it was held by Moab. It is evidently referred to in several prophetic denunciations whose fulfilment has been most literal. About 300 B.C. it had come into possession of the warlike Nabataeans, descendants of Nebaioth, the eldest son of Ishmael, who made it their capital, and it was known to the Greeks as Petra. Strabo, the Greek traveller and historian, describes it at the end of the last century B.C., as also did Pliny, the Roman writer, in the first century of our era. In A.D. 105 it passed under Roman rule.

Forgotten for Centuries.

Petra continued populous and prosperous as a trade depot until about the beginning of the fourth century, when the caravan route from the north, which had for so many centuries led past its portal to the Red Sea, was diverted to the Persian Gulf. After this it rapidly declined, and it is not heard of again until about A.D. 536. Even its very existence and site were forgotten, until it was visited and identified by Seetzen in 1807, and seen again by Burckhardt in 1812, the latter gaining access to it in the disguise of a Moslem pilgrim. Such is the history of the rock-hewn city of Petra, truly unique among the many wonders of the Orient.

Books Received.

Metallurgy and its Influence on Modern Progress. By SIR ROBT. HADFIELD, Bt., D.Sc., D.Met., F.R.S., F.I.C., M.Inst.C.E. (Chapman & Hall Ltd. 25*s.* net).

La Mort et la Biologie. Par HENRY DE VARIGNY. (Libraire Felix Alcan. 12 francs).

Harvard Eclipse Observations on January 14th, 1925. By EDWARD S. KING. (Harvard Reprint 27).

Joel Hastings Metcalf. By S. I. BAILEY. (Harvard Reprint 26).

The Rise of Modern Industry. By J. L. HAMMOND and BARBARA HAMMOND. (Methuen & Co. Ltd. 10*s.* 6*d.* net).

The Furniture Mite. Economic Leaflets No. 2. (British Museum—Natural History. 1*d.*).

The Classification of Flowering Plants. By A. B. RENDLE, M.A., D.Sc., F.R.S., P.L.S. Volume II: "Dicotyledons." (Cambridge University Press. 30*s.* net).

The Pagan Background of Early Christianity. By W. R. HALLEDAY, B.A., B.Litt. (University Press of Liverpool. 12*s.* 6*d.* net).

Eleventh Report of the Advisory Committee on Atmospheric Pollution. (H.M. Stationery Office. 5*s.* 6*d.* net).

Ancient Egypt. December, 1925. Part IV. (Macmillan & Co. 2*s.*).

Applied Chemistry. By C. KENNETH TINKLER, D.Sc., F.I.C. and HELEN MASTERS, B.Sc. Vol. II: "Foods." (Crosby Lockwood & Son. 15*s.* net).

Flower Scent. By F. A. HAMPTON, M.A., B.M., B.Ch. (Oxon). (Dulan & Co. Ltd. 6*s.*).

Stars and their Uses. By E. B. LEGGETT, B.A. (W. Heffer & Sons Ltd. 3*s.* net).

Graphical Methods of Plotting from Air Photographs. By LT.-COL. L. N. F. I. KING, O.B.E. (H.M. Stationery Office. 3*s.* net).

Migraine and other Common Neuroses. By F. G. CROOKSHANK, M.D., F.R.C.P. (Kegan Paul. 2*s.* 6*d.*).

Annals of Archaeology and Anthropology. Vol. XII: Nos. 3-4. November, 1925. (University Press of Liverpool. 6*s.*)

The Journal of the Quekett Microscopical Club. November, 1925. (Williams & Norgate Ltd. 3*s.* 6*d.* net).

Animal Life in the Sea. By R. J. DANIEL, M.Sc. (Hodder & Stoughton Ltd. 5*s.* 6*d.* net).

Proceedings of the Society for Psychical Research. December, 1925. (Robt. Maclehose. 7*s.* net).

The Microcosm. Edited by DOROTHY UNA RATCLIFFE, F.R.G.S. Vol. IX. No. 4. Winter, 1925. (2*s.* 6*d.*).

The Mummy. By SIR E. A. WALLIS BUDGE, K.B., M.A., Litt.D., F.S.A., etc. Second edition. (Cambridge University Press. 45*s.* net).

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Researches on the Song Factor in Birds.

By **Professor C. J. Patten, M.A., M.D., Sc.D.**

Professor of Anatomy, Sheffield University.

Author of "The Aquatic Birds of Great Britain and Ireland"; "Diurnal Migrations at the Tuskar Rock"; "Transatlantic Migrations of the Sora Rail," etc.

The song of birds is one of the most elusive things to submit to analysis, but their minstrelsy is being closely studied. The evolution of the song factor has yet to be traced out, but neither poet, musician, nor scientist can capture and label the inspiration of the melody.

PICTURE to yourselves a world without birds; imagine yourselves living in a pre-avian epoch amidst reptilian creatures, denizens of the air, the earth, and the seas, many of them monsters of colossal size, yet whose

LAUGHING JACKASSES IN PEALS OF LAUGHTER.

Our kingfisher—a brilliant feathered jewel—is a sedate little bird. This giant Australian cousin (almost as large as a crow) ever and anon bursts into the heartiest peals of human-like and very infectious laughter. While securing a photograph of these laughing jackasses I myself laughed aloud.

(Photographed from life, at Adelaide, by C. J. Patten).

vocal utterances were represented only by grunts, hisses or snorts.

How different is life on the globe at the present day with its throngs of avian choristers! Surely, in our own Isles "gentle music melts on every spray."

Yes, for countless ages our planet was inhabited by voiceless living beings. Many decades passed before even such primitive utterances as the stridulations of the grasshopper, the croak of the frog, the snort of the crocodile, or the hiss of the serpent, were capable of being produced. The reptilian dynasty was in itself an immeasurable time, and although it was remarkable for the evolution of many diversified creatures (highly organized in many directions), yet the power of producing vocal music hung fire.

It was not until birds emerged from this curious ancestry, and became highly specialized, that voice became a dominant feature of evolution. Birds—beautiful and fascinating creatures, hot-blooded, full of vitality, vivacious to the highest pitch—could no longer express their emotions silently. Alarm-notes, battle-cries, call-notes, and the full song proper itself, emanated and became keenly responsive.

The evolutionary characters of birds could never have reached such a stage of extraordinary perfection unless there had been, *pari passu*, active elaboration of the vocal apparatus. Birds—essentially aerial creatures, unsurpassed in powers of animal locomotion, birds—migratory creatures capable of undertaking periodic

SNOW-BUNTING.

A common winter-migrant in our Isles, found chiefly in the maritime counties. Both its song and its call-note are composed of pretty, bell-like sounds, often poured forth as the bird first rises from the ground.

(Photographed from life by C. J. Patten)

pilgrimages of vast extent o'er land and sea—if bereft of the faculty of producing modulated and in many ways highly differentiated vocal utterances, would be unable to maintain with efficacy their code of society. Sociability is an outstanding feature of bird-life; this is seen in the incessant verbal inquiries, vocal

messages, and so on, which serve to illustrate the frequent chatterings of many species. Musical sounds carry a long way, hence their primary use in birds; without these far-reaching utterances bird-partners might easily become separated to a dangerous degree.

The song of birds, apart from its motive, is in itself a product of evolution. It has been largely derived from the simpler call-notes, and to a less extent from the alarm-notes. These, rendered in rapid succession and subjected to variations, build up the song. Many of the simpler stanzas—for instance, those of the hedge-sparrow, reed-bunting, yellow bunting, and others, very clearly indicate that they are conversation notes strung together. The double call-note, syllabled *you-ee* is common to many birds, especially the "warblers." But while it varies considerably in pitch and tone, it is essentially melodious and lays the foundation of the unique "water-bubble" trills and rolls of the finished song.

Call-notes.

Several birds, in which the song has not evolved, nevertheless possess beautifully plaintive and melodious call-notes, as exemplified in those of the curlew, redshank, greenshank, ringed plover, and other shore-birds. Such notes are pre-eminently musical and carry a very long distance; they express sympathy in a marked degree, for they are enshrined in the cries of the helpless young, cries of distress for food, for warmth, for protection. These melodious strains are poured forth by the offspring for many weeks after it has left the nest. The parents reply in equally sympathetic terms. In most species which habitually frequent the open expansive beach the call-note may also serve as the alarm-note. Such is particularly noticeable in the case of the curlew, whose grand wild musical cry no doubt plays the part of a multiple code. Purely musical call-notes are chanted forth by migrating birds for the purpose of keeping the members of the flocks together when on their vast nocturnal peregrinations across land and sea. The alarm-notes and battle-cries have themselves, no doubt, undergone elaboration.

The hedge-sparrow still retains the single squeak in contrast to the rapidly repeated chatter—so rattling in character—of the angry magpie or missel-thrush. The battle-cry of the chaffinch, though repeatedly uttered, is disjointed and without rhythm or phrase; it may be said to form a link in the evolution of alarm-notes between those of the hedge-sparrow and magpie.

AUSTRALIAN BUSTARDS.

The hollow booming or rumbling sounds which the male bustard is capable of emitting, while he inflates his throat to a prodigious extent, must be regarded as vocal in character and therefore functioning as a song.
(Photographed from life, at Perth, Western Australia.)

Turning now to consider more particularly the formation and composition of the song, it is to be observed that among the premier vocalists many new notes and phrases (apart from a synthetic rendering of alarm and call-notes), are introduced, and a greater and more varying degree of modulation, pitch, colour-tone, rhythm, and other matters of vocal technique, are evident, all of which are correlated with varying degrees of emotional intensity.

In the building up and elaboration of song, it should be observed that *mimicry*, not only of other species of birds, but also of other animate as well as of inanimate musical sounds, is not wanting. But if the blackcap babbles like the brooklet; or if the tawny owl breathes forth the soft murmurings of the sighing night-wind through timbered glade; or if the wood-warbler's tremulous invocations are enshrined in the shimmering leaves; there is reason to believe that these melodies of *mimicry* have long since been handed down to the offspring, and are now reproduced in successive generations without tuition. While it is not too much to say that the song of birds no doubt is still evolving, elaborating, and evincing variations, it is important to remember that *the foundation of the vocal theme of each species* remains constant. It is true that in the phrases of some of our best avian singers—for instance, the song-thrush—the notes of other birds are often reproduced with a remarkable exactitude of tone and pitch, indeed, if we made an ultimate analysis of the theme of the song-thrush it would require little or no stretch of imagination on the part of the listener to come to the conclusion that almost every note has been borrowed.

Borrowed Notes.

He who has given attention to the study of bird utterances would here detect an extraordinary medley of other avian incantations. But this does not mean that the song-thrush set out on a special mission to learn to imitate the cry of the chick, the call of the partridge, the rasp of the corn-crake, the call-note of the wren, the battle-cries of the blackbird, the

AUSTRALIAN WHITE-BACKED MAGPIE.
In the British Isles the premier vocalists are usually small and sombre-plumed. The Australian magpies have a very noticeable piebald dress, and are as large as crows. Endowed with wonderful powers of modulation, their rich mellow carol is unequalled among European birds. They belong to the shrike family and have no affinity with our magpie, which is a corvine bird and whose vocal utterance is harsh and chattering.
(*Photographed from life, at Perth, Western Australia, by C. J. Patten.*)

chaffinch, the green-finch, and other utterances, almost *ad infinitum*! We must rather regard the bird-vocabulary — (may we call it the literature of avian music?) — as being of limited extent, hence overlapping in vocal sounds, simulating deliberated mimicry, seems to have been unavoidable. It is extremely doubtful whether, if the borrowed notes were reproduced by their rightful owners in chorus, the theme as a whole of the song-thrush would be in the least degree recognizable. There is an individuality in the manner and spirit in which each species sings; this is especially noticeable among the major vocalists.

WILLOW-WARBLER DEFIANT.
The male is here seen with stretched neck, lowered head, and partially spread wings, singing at another male. The association of pugnacity with song is dominant in the pairing season.
(*Photographed from life by C. J. Patten.*)

Singing in birds is an instinctive activity, just as much as is eating and drinking. The young bird, on hearing the parents sing, is often, though not invariably, awakened and stimulated into song; in captivity, however, young birds have sung typical songs without having had the opportunity of hearing the parents' song. On the other hand, it is true that instances have been cited, by trustworthy observers (to which I can add my testimony from personal observation), of true vocal mimicry, that is to say, of birds which acquired the song or part of the song of another kind of bird, the acquired part being a true phrase and not simply a mixture of a few scattered notes from various sources. Notwithstanding this accomplishment, the prescriptive theme of the individual is plainly recognizable.

In our Isles the full burst of song lasts for half the year with *interim* reinforcements of the sweetest lays from vocalists which arrive from far-off lands; during the remaining part of the year the perpetuation of song is held by a minority; year in and year out chirping conversations, calls, and alarm-notes, ring in our ears. All these delightful incantations have become as familiar as the sighing of the wind, the rustling of the leaves, or the rippling of the brooklet, and so, as a matter of course, it is only those of us specially interested in bird life who stop to analyse them.

We may now ask—What then is the purport of the song? It may be said at the outset that *sympathy*, so expressive in the call-notes, is supplanted in the joyous and passionate rhapsody of the song-proper by an expression of *emulation*, *rivalry*, and, in a great measure, *defiance*. The song, a message of love, of courtship and of wooing, is not only addressed to the expectant mate, but also to rival suitors as a warning not to pass the bounds of their rightful territory and trespass. The rival suitors reply in melodious strains, and so it comes to pass that throughout the spring season the avian "grand opera" plays its part. But this proclamation of right of territory may sometimes invoke a combative challenge; indeed, the association of pugnacity with song is extremely dominant in the pairing season. I have seen two robins when facing, sing at each other, come into close grips, free themselves, and once more closely approaching, sing again at each other, all the while assuming most defiant attitudes.

Many of us are familiar with the manner in which male birds will try to rival each other in song. I have noticed over and over again how each vocalist will perch on the topmost branch of a

SONG AND "DISPLAY" OF REED-BUNTING.
The bird was photographed whilst singing in front of its mate. The song is rhythmic and rather monotonous: it sounds like *chu-chu* oft repeated, and varies in pitch as little as the two ticking notes of a clock. During his highly emotional singing and after, the bunting "displays" his plumage by erecting his conspicuous black head-feathers and swaying his head excitedly from side to side.
(*Photographed from life by C. J. Patten.*)

tree or other conspicuous spot, but always within the confines of its particular territory, and there, in the most passionate and incessant strains, endeavour to allure the female. In birds it is well known that in courtship and wooing song plays a very important part, and that it is continued during the early period of wedlock to assure the female, as she patiently broods over her eggs, that all goes well.

Birds give forth their song with the greatest amount of vivacity and passion, and the finest songsters of the British Isles are, with few exceptions, small and sombre-plumed. The nightingale, peerless minstrel of the summer nights, is dull brown in colour, so is the garden-warbler, an excellent songster. Likewise the blackcap (the cap is small and inconspicuous), the reed-warbler, willow-warbler, whitethroat, sedge-warbler, skylark, wood-lark, and others, are modestly attired, possessing little or no contrast colours in the pattern of their plumage. On the other hand, the goldfinch, chaffinch, robin, and redstarts are examples of the few which display bright and contrast colours. But in far-off lands not a few species of charming songsters are clad in rich and attractive plumage, such, for instance, as the magnificent crimson cardinal (" Virginian nightingale ") of North America, and the superb snowy bell-bird of South America. I have also observed several species in Australia gaily attired and at the same time with most pleasing voices.

Princes of Song.

Space will not allow of full analysis of the songs of our birds with superior voices. Suffice it to say that some of the long smooth phrases of the nightingale remind one of the sighing cadence of the night wind's gentle whistle, descending through almost imperceptible gradations of the chromatic scale; or of the fervent whisper of the tiny brooklet or of the shimmering of delicate foliage. Next one hears the peerless minstrel letting loose a succession of chattering notes, silver-toned, yet defiant, subtle as they wane, mystic as they seem to float away on the night air, thrilling as the passionate theme rolls back with dramatic suddenness upon our ears. The blackcap, however, with its more limited compass and powers of execution, actually excels in tone the " Prince of Song " in some of its notes. Its " water-bubble " phrases are truly enchanting. For mellowness and singularly rich flute-like tone, for rhythm, time, and *motif*, the song of the blackbird comes *facile princeps*. The song-thrush, throughout its melody expresses joy, wild, buoyant, and decisive in character. It is on account of his indefatigable energies that this artist dominates the feathered choir. He oft repeats his verses, borrows freely from other composers, and is always in the limelight ! The faculty which the skylark possesses of letting flow a continuous tuneful melody, as he ascends on rapidly fluttering wings, almost surpasses admiration and wonder.

Anatomical Detail.

Such a marvellous faculty can only properly be understood by studying the anatomy and physiology of the respiratory, vocal, and muscular systems, which in birds have undergone marked specialization. In contrast to the foregoing melodious songsters, it is noteworthy that there are some birds, such as the great titmouse, the corn-bunting, the nightjar and the corn-crake, whose songs are unmusical though identical in purport with those of the sweetest avian compositions. The low hollow rumbling sounds, which the bustard, the emeu, and other birds, emit by inflating the spacious air-pouches which are appended to their throat, must also be regarded as vocal in character and functioning as a song.

In conclusion let us note that the vocal apparatus and its mechanism in birds are highly specialized and elaborated, but they also allow in every direction for the most perfect vocal results without tuition, differing in that respect from human voice production. It is obviously essential to the bird that such should be the case, seeing that (during part of the year) singing is as active and as regular a physiological function as eating and drinking.

Up to the present the Japanese Government have made a yearly subsidy to the Japanese dyestuffs industry. A new law has, however, recently been promulgated reducing this annual payment by about one-half, making it now 1,000,000 yen, and furthermore restricting such Government assistance to works producing only certain kinds of dyes.

We have received for review a specimen of the Koristka microscope advertised in this issue. The stand has coarse and fine adjustment, and is fitted with a small-sized Abbé condenser without centring adjustments. A 1/6th in. and 2/3rd in. objective have been sent, but it has not been possible to test the optical performance of the instrument in the time at our disposal. The firm offering these instruments for sale offers a week's free trial, and this affords the purchaser an opportunity of testing the actual instrument they consider buying. Assistance can usually be obtained from members of local societies, and the aperture, resolution and connection of the objectives accurately checked. We consider this course of individual examination the only satisfactory one, for there are few, if any, optical manufacturers whose manufactures are not subject to occasional variation or error.

Witchcraft and Sorcery in Ancient Mexico.

By Lewis Spence.

(Author of "The Gods of Mexico," "The Civilization of Ancient Mexico," etc.).

The ancient Mexican suffered under a highly organized system of sorcerers and witch-doctors, and was the victim of superstitions which find parallels among those of mediaeval Europe. The modern Mexicans are not great believers in the supernatural and sorcery is almost extinct.

PERHAPS no province of the dark monarchy of magic is plunged in such dense and unrelieved shadow as that of old Mexico, where the sorceries of East and West appear to have met and commingled in the making of mysteries more profound than either Europe or Asia dreamed. It is not a little curious that the secrets of this gloomy satrapy in the kingdom of the occult have not as yet been collectively chronicled, considering the romantic material they contain. Our chief authorities on the subject are the works of those devoted Spanish padres who laboured for the conversion of the native races during the century subsequent to the conquest of Mexico by Cortez. Therefore, we must search among anathemas for the history of the Black Art in the land of the Montezumas, for the native hieroglyphic paintings yield only a few passing references to occult practice.

A MEXICAN DEMON DEITY.

Witches.

The missionary friars from Spain and Italy found their chief opposition from that popular species of diabolism almost universally known as witchcraft. The cult of the witch, indeed, appears to have been as general in ancient Mexico as it was in Europe and Asia, and in its American form it bore so startling a resemblance to the witchcraft of the Old World, that it is difficult not to believe that both can be referred back to a common origin. Indeed, more than one of the zealous missionaries arrived at such a conclusion. "These women," says one, "are such as we in Spain call witches." But curiously enough, in old Mexico, as in Burma, the sabbath or convention of the witches was engaged in by the dead as well as the living, the evil ghosts who attended it being recruited from among those deceased women who had left young children behind them, and who, in consequence of their bereavement, were supposed to be particularly vindictive, wreaking their spite and disappointment on all who were so unlucky as to cross their path. They are represented in the ancient paintings as wearing black skirts on which cross-bones were depicted, and round their heads a fillet or band of unspun cotton, the symbol of the earth-goddess. They carried the witch's broom of dried grass, and they are frequently accompanied by owls, snakes, and other creatures of ill-omen. Their faces were thickly powdered with white chalk, and sometimes the cheeks were painted with the figure of a butterfly, the emblem of the departed soul.

Broomsticks.

One of the most trustworthy observers of native customs says of them: "they vented their wrath on people and bewitched them. When anyone is possessed by the demons with a wry mouth and disturbed eyes, . . . they say he has linked himself to a demon. The Ciuateteô (Haunting Mothers), housed by the crossways, have taken his form."

The divine patroness of these witches, who flew through the air upon their broomsticks and met at cross-roads, was the earth-goddess Tlazolteotl. The broom is her especial symbol, and in one of the native paintings she is depicted as the traditional witch, naked, wearing a peaked hat made of bark, and mounted upon a broomstick. In other places she is seen standing at the door of a house accompanied by an owl, the whole representing the witch's dwelling, with medicinal herbs drying beneath the eaves. Thus the evidence that the Haunting Mothers and their patroness present an exact parallel with the witches

of Europe seems complete, and should provide those who regard witchcraft as a thing essentially European, with considerable food for thought. A Mexican sorcery cult known as Nagualism was also permeated with practices similar to those of European witchcraft, and we read of its adherents smearing themselves with ointment resembling the "witch-butter" of the European hags, which was thought to aid flight through the air, engaging in wild orgies and dances, precisely as did the adherents of Vaulderie in Southern France, and casting spells on man and beast alike.

Native Magicians.

But there is plenty of proof that living women desired to associate themselves with the Haunting Mothers. A monkish writer tells us that these betook themselves to cross-roads by night, and, throwing aside their garments, drew blood from their tongues to sacrifice to the Father of Evil, leaving their clothes behind them as an offering.

Like their European sisters, the Mexican witches were in the habit of intoxicating themselves with some potent drug, so that they might in spirit traverse great distances or prophesy coming events. Says Acosta: "To practise this art, the witches, usually old women, shut themselves up in a house and intoxicate themselves to the verge of losing their reason. The next day they are ready to reply to questions. Some of them take any shape they choose, and fly through the air with wonderful rapidity and for long distances. They will tell what is taking place in remote localities, long before the news could possibly arrive. The Spaniards have known them to report mutinies, battles, revolts and deaths, occurring two hundred or three hundred leagues distant, on the very day they took place or the day after."

The high priest who presided over the Mexican witches' revels at the cross-roads was the god Tezcatlipoca, a deity of ill-omen, who took the place of Satan in the European witch-sabbath. He discoursed music for the sport of his devotees on a pipe made of the arm-bone of a deceased woman.

Apart from these evil women, but strikingly similar to them in practice and disposition, were the naualli or native magicians of Mexico. These men were masters of mystic knowledge, practitioners in the Black Art, sorcerers or wizards, holding communication with the dead. They were thought to have the power of transforming themselves into animals. They were not always evilly disposed, but as a class were notoriously feared and disliked. "The naualli," says the writer who first mentions them, "is he who terrifies people and sucks the blood of children during the night." "These are magicians," says Father Juan Bautista in his instructions to confessors, printed at Mexico in the year 1600, "who conjure the clouds when there is danger of hail, so that the crops may not be injured. They can also make a stick look like a serpent, a mat like a centipede, a piece of stone like a scorpion, and engage in similar deceptions. Others of them will transform themselves to all appearance into a tiger, a dog or a weasel. Others, again, will take the form of an owl, or a cock."

Nicolas de Leon, in a similar work, instructs the priest to ask the natives such questions as: "Art thou a sooth-sayer? Dost thou foretell events by reading signs, or by interpreting dreams, or by water, making circles or figures on its surface? Dost thou suck the blood of others, or dost thou wander about at night, calling upon the Demon to help thee? Hast thou drunk peyotl, or given it to others to drink, in order to find out secrets? Dost thou know how to speak to serpents in such words that they obey thee?"

The intoxicant peyotl, which the natives used to induce trance, is a species of vinagrilla having a white tuberous root, which was the part made use of. The Aztecs were said to have derived their knowledge of it from an older race who preceded them in the land. The intoxication it caused lasted several days. The natives masticated it and then placed it in a wooden mortar, where it was left to ferment. Another medicine employed by the naualli for the purpose of inducing ecstatic visions was an unguent known as teopatli, or "the divine remedy," a compound of the seeds of certain plants, the ashes of spiders, scorpions and other noxious insects.

Grim Demons.

The demonic beings who ministered to the naualli were numerous and fearsome. When night descended upon the pyramid-temples and market-places of old Mexico, and the beneficent sun-god had betaken himself to the underworld, it was a grim company indeed that came from the spirit-spheres to people the darkness. The demonology of a Mexican midnight was eloquent of the harsh fatalism of a barbarian people who had but newly entered upon the possession of an ancient civilization. From sunset to sunrise Mexico of the marshes was a city of dreadful night indeed.

Chief and most terrible of the tyrants of its dismal hours was Tezcatlipoca, "The Fiery Mirror," "He who Affrights the People," divine master of magicians, who took upon himself many fearful shapes and grisly disguises. "These," says old Sahagun, one of the missionary fathers, "were masks which he took to terrify the folk, to have his sport with them."

Perhaps the most menacing of the nocturnal disguises of this god, who wore the star of night upon his forehead, was the uactli bird, a species of hawk, whose cry of "yeccan, yeccan" boded a speedy death to him who heard it. Another shape in which he haunted the woods was as the "axe of the night." As midnight approached, the watching acolytes in the temple precincts might hear a sound as of an axe being laid to the roots of a tree. Should the courageous wayfarer penetrate the wooded places whence the sound came, he was seized upon by Tezcatlipoca in the form of a headless corpse, in whose bony breast were "two little doors meeting in the centre." It was the opening and closing of these, said the Aztecs, which simulated the sound of a woodcutter at work. A valiant man might plunge his hand into the strange aperture and, if he could seize the heart within, might ask what ransom he chose from the demon. But the craven who encountered this awful phantom would speedily perish from fear. It is now believed that this peculiar sound is made by a certain nocturnal bird in the Mexican forests.

Animal Hauntings.

Hauntings of all kinds, indeed, were regarded as due to the agency of Tezcatlipoca. Especially feared were those forms of him, headless and without feet, which were said to roll along the ground, scattering maladies and diseases as they went. These were believed to augur speedy death, either in battle or, still worse, by sickness, for a "straw death" was looked upon by the warlike Mexicans as a disgraceful end, unworthy of a soldier. But if the phantom was boldly grappled with and forced to purchase its release with a thorn of the maguey plant, it was thought that the earnest thus secured would endow its owner with good fortune for the rest of his life.

Sometimes Tezcatlipoca would appear as a coyote, sometimes as a turkey-cock. "They sometimes painted him with cock's feet," says the priestly interpreter of one of the native manuscripts, "for they said at times only his feet were seen, and that at others he appeared sideways," alluding probably to the fact that fear-haunted wretches imagined they beheld him as they looked sideways out of the corners of their eyes.

It is strange to find the banshee in ancient Mexico, or at least a spirit which closely resembled her. The natives knew her as Cuitlapanton, and Sahagun says that she resembled "a little fairy." To see her, as in the case of her Irish congener, meant death or overwhelming misfortune. She had a short tail, long matted hair, which fell to her middle, and, like the banshee, she waddled like a duck, emitting a dolorous cry the while. All attempts to seize her were vain, as she would vanish in one place and immediately reappear in another.

Another grisly apparition of the Mexican night was a death's head which was in the habit of suddenly presenting itself to those bold enough to venture abroad after dark. It would dance in circles on the ground, making weird moaning. If one halted when pursued by this ghostly skull, its gyrations ceased. Like the Cuitlapanton, it could not be grasped because of its mercurial habit of sudden disappearance, but it persisted in following the person who fled from it until he reached the door of his dwelling.

Demons no less dread were the Tzitzimime, who had a stellar connection, and who were looked upon by the Mexicans in much the same manner as the mediaeval Christians regarded the fallen angels. An ancient myth tells us that at one time they dwelt in heaven, but because of their sins were expelled from its delights. It was perhaps as the dwellings of the Tzitzimime rather than as these demons themselves that the stars were thought of, but their connection with the orbs of night is clear. They are represented in the manuscripts as taking the shapes of noxious insects, spiders, scorpions, and so forth.

Demon Goddesses.

One of the most terrifying figures in this stellar demonology is the goddess Itzpapalotl, who has the attributes both of the butterfly and the dragon—a hideous mingling of the insect and the earth-monster. Another was Yacatecutli, a personification of the merchant's staff, to whom the pedlars of old Mexico offered nightly sacrifices of their own blood, drawn from their ears and noses, and smeared over a heap of the staves or bamboo walking-sticks which they generally carried. These, in the exigencies of travelling, took the place of the idol of their patron deity. Once a year, too, they celebrated his festival with sanguinary rites in their own quarter of the city. At certain seasons of the year the natives were in the habit of sealing up every possible loophole in their houses, doors, windows and chimneys, lest the baleful influence of the dead witch-women or stellar demons should penetrate their dwellings and injure them or their children. The beams of the stars were dreaded perhaps more than anything else, and even the gods themselves were not immune from astrological influence.

Magical enterprises and experiments were usually timed by sorcerers to take place during the second, fifth or seventh hours of the night, which were naturally the most dreaded by the common people because they were presided over by gods of evil repute, and thus were considered favourable to the appearance of demons or phantoms and the assemblies of witches.

Night, too, was naturally the hey-day of the sorcerer or naualli, and certain members of this caste seem to have practised vampirism and to have taken the shape of werwolves or rather wer-coyotes.

Those who desired to injure an enemy by spells and other enchantments, would go by night to the dwelling of the naualli and bargain for the drug or potion by means of which they hoped to be revenged. From certain passages in the old authorities, it would seem that these sorcerers lived in huts built of wooden planks gaily painted – perhaps a development of the lodge of the medicine man with its brightly coloured symbolism.

Nagual Cult.

During the hours of darkness the priestly occupants of the teocallis or temples carefully replenished the braziers, whose fires were supposed to exercise a deterrent influence upon all evil visitants to the earth-sphere. At stated intervals, too, they beat drums and sounded conch-shells to drive off the demons of gloom, and the trembling peasant as he lay in his reed shack and listened to the reverberation of the tympani of serpent-skins, the gongs and the rude horns of the sacred guardians of his peace, must have been heartened by the distant and reassuring clamour.

All the terrors of Spanish ecclesiasticism could not put an end to the practice of magic among the Mexicans. The minor feats of sorcery flourished in every Mexican town and village. Sahagun tells us how a class of professional conjurers existed who could roast maize on a cloth without fire, produce a spring or well filled with fishes from nowhere, and after setting fire to and burning huts, restore them to their original condition. The conjurer, asserts the chronicler, might on occasion even dismember himself and then achieve the miracle of self-resurrection !

Perhaps a higher caste of the naualli were the " master magicians," who were also known as teotlauice or " sacred companions in arms." Entrance to this very select order might only be attained after severe and prolonged tests of initiation. The head and patron of the society was the god Quetzalcoatl, or " Feathered Serpent," a deity of the mysterious elder race, the Toltecs, who had been forced from the soil of Mexico by the inroads of the less cultured Aztecs and allied tribes. Divination and the kindred arts were professed by diviners, whose principal instrument was the tonalamatl, the " book of days," or calendar. When a child was born one of these priest-seers was called in and requested to cast its horoscope. But as a general rule no enterprise of any kind was engaged in without taking the advice of this brotherhood.

The basis of the Nagualist cult already alluded to was the belief in a personal guardian spirit or familiar. This was known as the nagual, and was attached to each child at its birth. In a History of Guatemala written about 1690 by Francisco Fuentes y Guzman, the author gives some information regarding a sorcerer who on arrest was examined as to the manner of assigning the proper nagual to a child. When informed of the day of its birth, he presented himself at the house of the parents, and taking the child outside invoked the demon. He then produced a little calendar which had against each day a picture of a certain animal or object. Thus in the nagual calendar for January, the first day of the month was represented by a lion, the second by a snake, the eighth by a rabbit, the fourteenth by a toad, the nineteenth by a jaguar, and so on. The invocation over, the nagual of the child would appear under the form of the animal or object set opposite its birthday in the calendar. The sorcerer then addressed certain prayers to the nagual, requesting it to protect the child, and told the mother to take it daily to the same spot, where its nagual would appear to it, and would finally accompany it through life. Some of the worshippers of this cult had the power of transforming themselves into the nagual. Thomas Gage, an English Catholic who acted as priest among the Maya of Guatemala about 1630, describes in his " New Survey of the West Indies " the supposed metamorphosis of two chiefs of neighbouring tribes, and the mortal combat in which they engaged, which resulted in the death of one of them.

Transformations.

But a Nagualist of power was by no means confined to a single transformation, and was capable of taking on many and varied shapes. Speaking of one of the great magician-kings of the Kiche of Guatemala, the Popol Vuh, a native book, states that Gucumatz, the sorcerer-monarch in question, could transform himself into a serpent, an eagle, a tiger, and even into lower forms of life. Many of the confessions of the natives to the Catholic priests remind one forcibly of those which were discovered by the European witch trials of the sixteenth and seventeenth centuries. Thus an old man in his dying confession declared that by diabolical art he had transformed himself into his nagual, and a young girl of twelve confessed that the Nagualists had transformed her into a bird, and that in one of her nocturnal flights she had rested on the roof of the very house in which the parish priest resided.

When the wonderful story of Mexican magic comes to be written in full, it will constitute one of the most enthralling chapters in the mysterious annals of the Black Art, rivalling in interest the chronicles of mediaeval sorcery and the secrets of the grimoires.

Private Sea-water Aquaria.

By T. A. Stephenson, D.Sc.
(Zoology Department, University College, London),
and
W. Edgar Evans, B.Sc.
(Royal Botanic Garden, Edinburgh).

Small sea-water aquaria can now be kept even in inland places. It is to be hoped that this extremely practical article will encourage schools and societies to experiment with small tanks.

In this country at the present time a successful private marine aquarium, at any rate in any inland place, would appear to be a rarity. The keeping of small aquaria seems to be a somewhat fluctuating vogue, which ran its course in Britain during the last century, but which is now somewhat at a discount. In Germany, on the other hand, it was extensively practised before the war, and is now reviving again. The outburst of aquarium-keeping, which occurred in England about the middle of last century, received its impetus from the writings and lectures of P. H. Gosse, who popularized for the first time the idea that marine animals could be kept alive away from the sea.

New Ideas.

These aquaria must have been limited in scope in many cases; but now, when more is known of the art of maintaining sea creatures in health, more can be done than is generally realized. There is an idea current that an efficient aquarium can only be run upon a large scale, and under conditions not available except at a biological station. It is naturally not possible for everyone who wishes to study marine life to have continual access to such a station; but it is possible, nevertheless, to construct and maintain a private aquarium which will keep a reasonable variety of animals in a perfectly good state of health. This end can be attained inland as well as by the sea, and it need not be inordinately expensive.

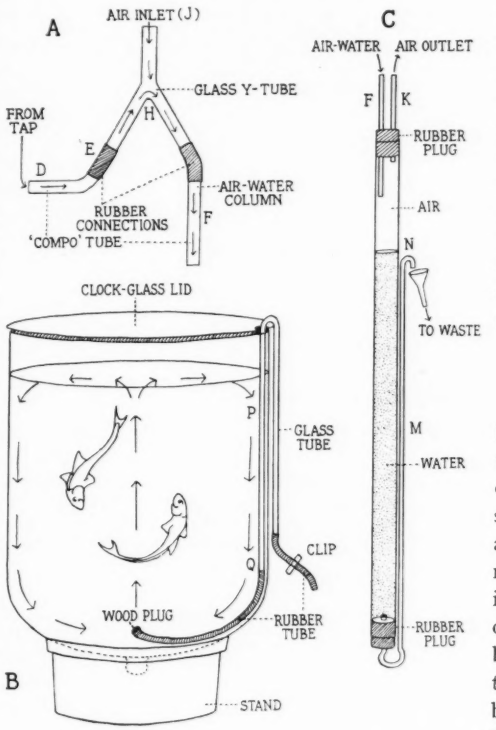


FIG. 1.
DIAGRAMS TO ILLUSTRATE THE AERATION-APPARATUS DESCRIBED IN THE TEXT.

We propose to consider here the construction and maintenance of a small marine aquarium. The problems connected with a large one are naturally different in many respects, and are not within our province at the moment. Neither can we touch upon the special types of aquaria required for keeping microscopic animals, nor those needed for the rearing of eggs.

Details.

In the first place, it is useless to start a marine aquaruim unless a good deal of pains can be spent upon its construction, and a certain amount of time given to it regularly. It can "go wrong" in innumerable ways, and will do so with little provocation; but given the necessary attention it may be expected to behave perfectly well after a little experience has been gained. It should not require more than half an hour a day, and a couple of hours once a week, to keep things going satisfactorily once they are under way, and apart from accidents.

Let us now consider details. To begin with, there is the question of tanks. It is the best plan to avoid rectangular vessels of any kind. These are either costly, and involve joins in their structure (a source of trouble) or, if made wholly of glass and all in one piece, they still have corners and consequently are

FIG. 2.
TWO SPECIMENS OF THE ANEMONE *TEALIA FELINA*.
[*Photo by F. Schensky.*

less well adapted to promote perfect circulation of air and water than vessels without angles. The ideal vessel is a cylindrical bell-jar, of comparatively wide diameter in proportion to its depth, and with a curved bottom. Such may be most easily obtained from a wholesale dealer in cemetery furnishings; they are normally used for covering wreaths. They are usually stocked in a series of sizes the diameter of which, at the mouth of the bell, differs by about half an inch between the sizes, and may be obtained either deep or shallow. Useful sizes range from 10-11 in. in diameter by 11-13 in. in depth, though smaller ones may be successfully employed in many cases.

Aeration Devices.

Next, there is the matter of aeration. Many methods have been devised at one time and another, and it would occupy too much space to describe a variety of these here. However, for the type of aquarium we are now dealing with, the best method is undoubtedly to create a stream of air under fairly constant pressure, and to introduce this stream into one's tank, allowing it to bubble up continually from the bottom. The stream is finely subdivided as it enters the water by being passed through a plug of porous wood, the bubbles so produced being very small and numerous.

The maintenance of this stream of air may be attained in more than one way. There is on the market, for example, a small and compact type of pump (it may be obtained from L. Hecht & Co., Berlin, S.W. 68, Ritterstrasse 48, and costs £2 4s.), which can be worked by an ordinary water-tap, and will provide the necessary supply. The same end may, however, be obtained by means of another apparatus which, though rather elaborate, is inexpensive and can be fitted up by anyone who likes doing things for himself. This apparatus we will now describe with the help of the diagrams in Fig. 1, the stream obtained from it being sufficient to aerate twenty tanks or more. The essential parts of the system are as follows:—

Explanation of Diagrams.

(1). *A*, *Fig.* 1. This consists of a glass Y-tube of about ¼ in. bore (obtainable from any dealer in scientific apparatus), placed upside-down. At D a length of ordinary "compo" ¼ in. gas-pipe (as sold by any plumber) is attached to one arm of the Y-tube by a rubber connection (E); through this water from

a tap is allowed to trickle so that it passes slowly over the bend H in the Y-tube, and down the other arm of this, taking with it as it goes air which enters at J, the open end of the Y-tube. F is another length of similar "compo" pipe, again attached by rubber tubing to the glass Y-piece; this conducts the flow of mixed air and water to the second part of the apparatus.

(2). *C, Fig.* 1. This consists of a six-foot length of wider tubing, one inch in bore, and provided with a rubber stopper at each end; it may be made of "compo" if it is to be exposed to the weather, or of glass, for inspection, if situated indoors.

FIG. 3.
WOLF-FISH, *ANARRHICHAS LUPUS*.
[*Photo by F. Schensky.*

Tubing.

Through the stopper at its upper end two ubes will be seen to be inserted; one of these is the tube (F) bringing the mixed stream of air and water from that part of the apparatus first described; the other (K) will be mentioned later. Through the lower stopper a single $\frac{1}{4}$ in. "compo" tube penetrates (M), this being the water-outlet and taking the course shown in the figure. The air-outlet is through the $\frac{1}{4}$ in. "compo" tube (K), already mentioned, and in order to avoid all possibility of water being accidentally drawn into this along with the escaping air it is important to see that the end of the inflow-pipe (F) projects beyond that of the air-outlet (K) to a distance of about three inches, and that the bend (N) of the water-outlet is situated some six inches lower, as indicated in the diagram. This part of the apparatus not only acts as a separator in which the mixed air and water column becomes separated by gravity; it also plays an important rôle in adjusting the pressure at which the air supply is delivered to the aquarium tanks. This is brought about by the fact that any check to the outflow causes an accumulation of air within the separator, this resulting in a corresponding depression of the water level within the one-inch tube of the apparatus. Since the pressure at which the air is delivered depends upon the difference between the level of the water within the separator and the point (N) at which it is obliged to escape, it follows that an increase in pressure is thus brought about, and that this increase will continue till it is just sufficient to overcome the check.

The Tank.

(3). *B, Fig.* 1. Here we have a tank. This is supported by setting its lower end in a glass dish such as those used for packing certain brands of preserved meats. Other means of support can be devised, of course, but the one shown is simple, cleanly and cheap. The tank is covered by a concave clock-glass of suitable diameter, a very suitable form of lid, which keeps out dust, prevents excessive evaporation and, on account of its concave surface, returns to the tank any liquid condensed upon it. Running down the inside of the bell is a narrow glass tube (P), through

which air is delivered ; this ends at Q, but is continued by a length of rubber tubing sufficient to reach the centre of the tank at its lowest point. Into the open end of this rubber tube is inserted a small cylindrical plug of wood, well dried wood of the common lime being very suitable for the purpose ; through the almost microscopic vessels of this the air is driven. The delivery tube (P) passes out of the tank through a notch in the glass cover, bends downwards outside the tank and is attached by a rubber connection to the tube (K) from the separator. The air is thus made to enter the tank in a stream of exceedingly fine bubbles which rise to the surface of the water and there spread out radially in all directions. The currents so produced in the tank are indicated by arrows in the figure ; it will be seen that every part of the water is moved and no stagnant areas are left. This is one of the main factors in the success of this system.

(4). It is now only necessary to describe the relation of those parts of the system already mentioned one to the other. For convenience the separator should be placed close to a sink or drain, into which the water issuing from it can pass. It should also be kept as near to the floor or ground level as possible. The Y-tube by which the air is drawn in should be directly above the separator, and at as great a height above it as can be arranged ; if a copious and satisfactory air-supply is to be expected this should not be less than twice the length of the one inch tube of the separator. Where possible it is best to instal this part of the apparatus in the open-air (the tube F may conveniently be run down the outside wall of a house). It is inadvisable to place the air-inlet near the ceiling of a room where foul air is apt to collect. The aquarium itself may, of course, be placed in any suitable position, but it should always be borne in mind that a room subject to much fluctuation in temperature will not prove satisfactory for the purpose.

Multiple Aquaria.

Where a number of tanks are to be aerated it is convenient to provide a length of brass tubing into which are screwed and soldered an equal number of gas-cocks of the pattern fitted on laboratory benches. This is fixed behind the tanks, and the rubber connections from them slipped on to the cocks ; while the pipe (K), bringing air from the separator, is attached to one of its ends, the other being plugged. In place of cocks ordinary screw-clips may be used, and it is indeed an advantage to regulate the actual air-supply to each tank by this means, even where cocks have been fitted. These clips are, of course, attached to the rubber connection between the tank and the delivery pipe.

We may now turn our attention to stocking the aquarium, having indicated the method of constructing it.

I. *Sea-water.* If the aquarium is situated away from the sea, water may be obtained either from a biological station or from a dealer. The Marine Biological Station at Plymouth sends out water taken anywhere beyond three miles clear of land, charging 3s. 6d. for each carboy containing five gallons of water ; the carboy is itself charged for at 15s., but this is recoverable if it is returned in good condition, while carriage by rail has also to be met. There are other Biological Stations at Millport (Clyde), Port Erin (I.O.M.), Newcastle-on-Tyne (Dove Marine Laboratory), etc. (of these the first at any rate will supply water), and some scientific dealers will undertake to obtain it. A good stock of water should be kept in hand in case of accidents ; it may be stored in carboys in a cool dark place, and should keep satisfactorily provided the carboys were perfectly clean and the water a good sample in the first place. Once a tank has settled down and its inhabitants are happy, the water may not need to be changed for months, perhaps not for a year or more, except for an accident.

Furnishing the Tank.

Artificial sea-water is not a good thing to try unless it is carefully made up by an accurate method and with very good chemicals. If water is obtained in person by the aquarium-keeper, it should either come from a clean part of the coast or, if it must be taken near to any point of pollution, it should be collected some distance out at sea.

II. *Sand, stones, etc.* Some animals will like stones to shelter under or adhere to, especially such as are full of holes and cracks into which they can creep. Nicely coloured stones and pieces of coral also add to the effect of the tank without detracting from its utility. These can, if desired, be built up in a concrete matrix, shaped to fit the tank, into effective backgrounds and miniature caves. All stones used must be very thoroughly scrubbed and rinsed to entirely free them from any trace of organic matter which might decay and foul the water, and it is not at all a bad plan to boil them before doing so to kill any undesired organisms attached to them. Where a concrete mould is formed, a hole must be left through which the aeration tube can pass ; while it must be remembered that the concrete should be allowed to set thoroughly and should be well washed for a week or

two in tap-water before being used in the aquarium. Certain animals will want a sandy bottom in which to burrow; the best thing to use here is coarse sand or fine gravel from the sea-beach, and this should receive treatment of the same kind as in the case of stones.

Avoid Sea-weeds.

The use of sea-weeds in tanks of the type here described is not recommended, except in exceptional cases and only after considerable experience; they are quite unnecessary, and only add to the possible sources of contamination. Similarly, sponges and other encrusting growths should at first be rigidly barred.

III. *Animals.* Biological stations will supply living animals if these cannot be collected personally. It is the better plan at first to keep different kinds of animals in separate tanks; after due experience a certain amount of mixing may be adopted, but this needs to be judiciously done if only to obviate one sort devouring the other. The range of creatures suitable for an aquarium such as is described here is not unlimited but is, however, fairly wide. To indicate the kinds of animals which may be expected to do well we give below a small selection, most of which have actually been kept for long periods in such an aquarium by one of us.

FISHES. Blenny (*Blennius pholis*), young Lumpsucker (*Cyclopterus lumpus*), Gobies (*Gobius ruthensparri* and *G. minutus*), Bullheads (*Cottus scorpius*, *C. bubalis*), Butterfish (*Pholis gunellus*), Rocklings (*Motella*), Pipefish, small Wrasse (more than one species), Sticklebacks, etc.

ECHINODERMS. Starfish of certain kinds (*Asterias*, *Solaster* and *Henricia* for example), Sea-urchins (*Echinus miliaris*), Brittle-stars (*Ophiothrix*, etc.).

FIG. 4.
A JELLYFISH—*CHRYSAORA HYSCOSCELLA*. [*Photo by F. Schensky.*

MOLLUSCA. Periwinkles (*Littorina*), Top-shells of certain sorts (*Trochus cinerarius*), Chitons, Scallops, etc. The small Cuttlefish *Sepiola* is interesting and may be kept; other Cuttlefish and Octopods are not good subjects. Sea-slugs are attractive, but difficult to feed, though *Aeolidia papillosa* can be kept if given *Actinias* to eat.

Interesting Subjects.

CRUSTACEA. Crabs do well but are inclined to be savage and to devour one another. Edible crab (*Cancer*), Swimming-crab (*Portunus*), Spider-crab (*Hyas*), Shore-crab (*Carcinus*), Hermit-crab (*Eupagurus*), Squat-lobster (*Galathea*), can all be easily kept. Prawns and Shrimps are interesting, becoming very tame (*Pandalus, Mysis, Hippolyte, Palaemon*, etc.).

WORMS. Fan-worms are spectacular—e.g., *Sabella* and *Botomilla*. *Pomatoceros* is less interesting but easy to keep and common. As a scavenger, *Polynoe* can be recommended.

SEA-SQUIRTS. Simple forms—*Clavellina* and *Styelopsis*. Compound forms—*Botrylloids* do well if collected without injury in the first place.

ANEMONES. *Tealia* is good, as are also *Sagartia* and *Actinia*. Many rarer kinds do equally well and some of the showy foreign species have been kept. *Metridium* is less suitable.

OTHER THINGS. Some kinds of hydroids will in time spontaneously make their appearance and will even liberate their medusae.

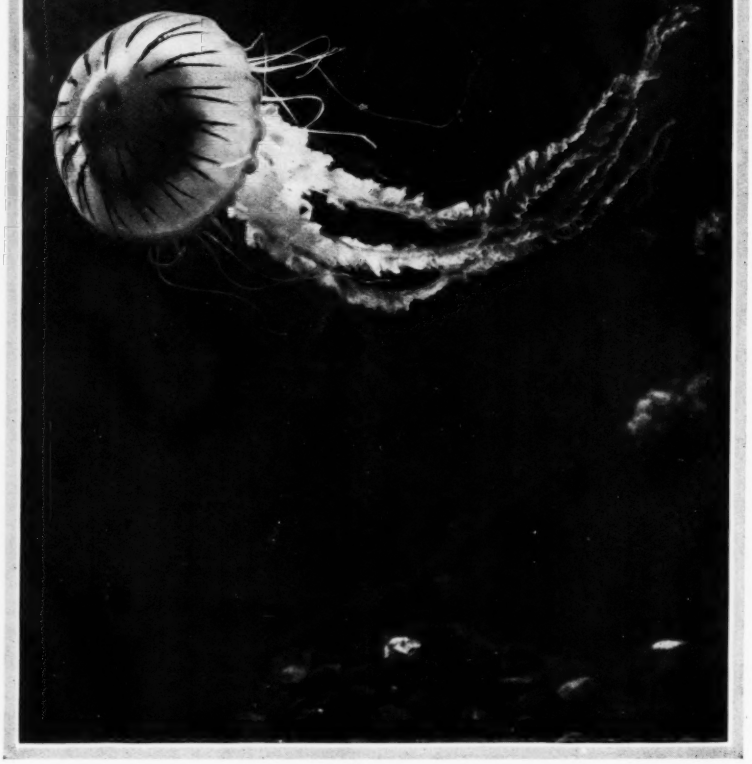


FIG 5.
PLUMOSE ANEMONE, *METRIDIUM SENILIS*. [*Photo by F. Schensky.*

Feeding.

IV. *Food*. Animals in aquaria should not be fed too freely; they will do better if given only enough for their needs. Whenever possible they should be fed individually. Rejected food and excreta from the creatures must be removed from the tank as soon as noticed, to prevent any fouling of the water. In this connection the use of metal instruments should be avoided, only those made of glass or of wood being allowed to come into contact with the water or the animals. The kinds of food which can be given are many, but the best and easiest plan is to keep in one tank a stock of live mussels (*Mytilus*) and to feed the animals with fresh mussel-flesh. In our experience most animals thrive on this diet, and we have seldom had to use anything else. Different kinds of animals need meals at different intervals; crustacea and echinoderms should be fed at least twice a week; fishes three times if adult, a little every day if young; anemones from once a week to once a month, and so on.

V. *Temperature*. In some parts of the country the water in the aquarium may become too cold in winter. This can be obviated by warming the room in which it is situated, though an effective hot-water circulating system to warm the tanks can be constructed from an empty paraffin can, a bunsen-burner and some glass or metal tubing. In this case the tanks are best set upon hollow wooden stands and the warm pipes led underneath these. For a mixed collection of animals a temperature of about 50° F. is excellent.

Control.

A more difficult matter is excessive heat in summer. Placing the tanks within a larger vessel in which cold water from a tap circulates is a means of overcoming this difficulty; it is better, however, to choose a room not exposed to the hot sun of summer, a precaution which in a majority of cases will prove sufficient. We have not space here to consider refrigerating apparatus. In practice, direct sunlight upon the tanks should be avoided, except in the case of special creatures. Many anemones give their best display at night.

VI. *Maintenance*. Before any animal is introduced into the tanks already stocked it should spend a probationary period in a separate vessel. Only when it is seen to be in good health should it be

admitted to a tank already settled down and in good working order. Moreover, a sick creature may be benefited by special attentions as, for instance, frequent changes of water, special aeration and so on, which can be given in this way only. Sedentary animals adhering to stones, etc., should have the object to which they are attached thoroughly scraped and cleaned before being placed in the tank, so that nothing may remain which might decay. Animals collected may have had a large meal prior to being caught, and should be allowed to get rid of this in the probationary tank.

The aquarium once started, its maintenance is chiefly a matter of regular attention and, above ali, cleanliness. Everything must be kept clean and dirt or slime produced by the animals must be constantly removed, as well as food refuse and any dead or sick creatures. The water should be changed when it shows signs of deterioration, and the tank and its contents at the same time cleaned. Provided a good sample of water is in the first instance procured, changes in its chemical or physical condition need not necessarily be considered in the case of an aquarium of the present type; such considerations, however, are important in the case of a large aquarium. Even in a small one, although in practice one can get on quite well without controlling the hydrogen ion concentration of the water, at the same time if measures are taken to ascertain and adjust this factor, it may be expected to lead to better results than could otherwise be obtained, in some directions at all events. The means of doing this are indicated in Sister Monica Taylor's article in the January issue of *Discovery*; space forbids further consideration of it here. Evaporation proceeds extremely slowly in a covered bell, and it is scarcely worth while testing this with a hydrometer or making up loss with distilled water, though this can, of course, be done if necessary.

VII. *Cost.* We cannot give the exact cost of setting up an aquarium, so much depends upon the circumstances under which it has to be constructed; but it should be possible to fix up, aerate and stock several tanks for about £10.

VIII. *Advantages.* It is hardly necessary to enumerate the advantages which may be gained by keeping an aquarium; we start on the assumption that anyone who wishes to keep one will have recognized these before deciding to set one up. This article does not pretend to cover the subject of aquarium-keeping even in outline, and it must be said that it is an occupation presenting many " snags " for the unwary; we have tried to show that a small aquarium of an efficient type is possible even away from the sea, and that it can be made from fairly ordinary and accessible materials. We should like to say also that really good health can be expected in the animals, with the described system of aeration; it is not a question of just keeping them alive and nothing more. The photographs illustrating this article are by F. Schensky, Helgoland, from specimens in the Helgoland Aquarium, by whose permission they are here reproduced. As already mentioned, *Tealia* is a good subject for a small tank, *Metridium* less so; the Wolf-fish shown is only suited for a large aquarium. *Chrysaora* can be reared in a small aquarium, but the problem of feeding it would be difficult except by the sea where a good supply of its natural food could be obtained.

Two Chinese Figurines.

By C. M. Bowra.
(*Fellow of Wadham College, Oxford*).

These curious figures found in Chinese graves present a problem. They do not represent a Chinese type, but are certainly statuettes of foreigners. The author suggests a Persian or West Asiatic origin.

In the last fifteen years large numbers of clay images from Chinese graves have found their way into collections in Europe and America. Usually they represent either animals or men and women of undoubted Chinese type; but there are a few rare examples which represent members of other races. I have in my possession such a specimen. It is 10.9 in. high, and made of the brittle, light-yellow clay, commonly used in figures of the T'ang period, and traces of what was once a coat of red wash survive on it in patches. (Fig. 1).

The comparative slimness of the figure and the quality of the clay point to its date being in the T'ang Dynasty (A.D. 618-905). Its provenance is fortunately certain. It comes from Lo-yang, in Ho-nan, one of the capitals of the T'ang. What it represents is less certain. The figure has a beaky nose and a beard; it wears a conical hat which swells out round the

temples into a thick band, and it is clothed down to the knees in a tight-fitting frock-coat; the legs are covered in loose-fitting boots, rather like snow-boots. In a small private museum in Peking there is a rather similar specimen made of a pale clay, covered with a thin lemon glaze, 11.3 in. high. This second figure (Figs. 2 and 3), has the same beaky nose, conical hat, long coat and boots; the right hand carries a pestle and mortar. The figure differs from Fig. 1 in one or two details. His moustache is thicker and his beard broader and shorter; his hat has, in front and behind, flaps which are folded up; his coat is drawn in by a belt and the toes of his boots curl upwards. In the collection of Mr. George Eumorphopoulos there are four figures not unlike these two. One is a pedlar, bent under the weight of his pack; two others are servants in tail-coats, and the fourth strikes a grimacing attitude.* All four have beaky noses and beards and all four wear conical hats with folded flaps like Fig. 2

FIG. 1. FIG. 2. FIG. 3.
CHINESE T'ANG FIGURES REPRESENTING WESTERN ASIATIC TYPES.
Left.—The author's figurine; Centre and right—Two views of a Pekin private museum specimen.

Whom do these figures represent? Neither their clothing nor their physiognomy is Chinese. They do not wear the small tight-fitting cap shown in most T'ang figures, nor the loose jacket and baggy breeches. The nose and beard are even stranger. No Chinese ever had a Roman nose, nor does their grave pottery ordinarily represent it; and no Chinese can grow a full bushy beard and moustache; at the best he can grow in old age a few straggling hairs on his chin. We must look outside China if we are to find the originals of these.

It might have been expected that Central Asia, the home of so many races, would have produced similar types; but it has not. The figures in the frescoes, unearthed by Sir Aurel Stein, are more like Indians than anyone else. They are clean-shaven except for an occasional moustache, and their noses are not remarkably arched; their head-dresses are of the Chinese kind and their clothing hangs loosely in elaborate folds. But farther West our type is commoner both in life and in art. The modern Kurd is not very unlike our figures, and the art of the different cultures which have existed in what is now Persia shows curious parellels to them. The same physical type is found in Achaemenid times on the stone reliefs of Xerxes. There is in the British Museum a gold plaque from the Oxus of slightly later date which represents a bearded man with an arched nose, wearing a conical hat, which falls back because he has let down the rear flap and tied it under his chin; his coat, which falls to his knees, is fastened round the waist by a belt. In Berlin there is a silver statuette of the same period with similar features, wearing a similar hat and clothing, partly concealed under a large cloak. The persistence of the type into later generations can be seen by a glance at any series of the coins struck by the Kings of Persia and Parthia. Antiochos I, of Commagene, has much the same features and hat in the stone relief on Nimrud Dag, and an Indo-Bactrian silver bowl, dating from the third or fourth century and now in the British Museum, shows a huntsman of the same appearance and wearing the same head-gear.

(*Continued on page 73.*)

* Hobson. Catalogue of the Eumorphopoulos Collection. No. 196, Plate XXXV; Nos. 297-298, Plate XLVI; No. 195, Plate XXVIII.

Sand in Magical and other Ceremonies.

By Maurice A. Canney.

Sand is an important ingredient in symbolic magic, and it is only little by little that the mysteries connected with its use are being cleared up. Archaeologists have often been puzzled by its presence in peculiar sites, and there is still much to be done before its true significance can be appreciated.

It is well known that in the East sand has been used for many centuries in fortune-telling and divination. Rows of prints are made in the sand with the finger-tips and, by means of these, future events are predicted; or a square is drawn in the sand, in which letters are written in a circle, and the person whose future is to be told is ordered to put a finger on one of the letters. The use of sand in ritual ablutions is also familiar. Among the Mohammedans, when water is not available, sand may be used as a substitute.

It has been made common knowledge also that among North American Indians drawings or paintings made in sand, or figures made of sand, play an important part in magical and religious ceremonies. Some of these sand drawings and paintings are very elaborate, as may be seen in the reports of the Bureau of American Ethnology. A similar use of sand is found in Central Australia. Sand designs are used also in India. When I was in Calcutta Mr. Kalipada Mukerjee drew for me two designs which are used in the Hom Ceremony. One of these figures in the worship of the goddess Sakti (Power) (see Fig. 1). Sand is spread on the earth or on a square tray made of copper. Then in the centre of this a lotus design is drawn with holy grass. In the circle of the lotus is drawn a double triangle, and in the middle of this, fuel is arranged in a pile. The pile is kindled with holy fire, and clarified butter is poured upon it. A different and simpler design is made on sand for the worship of gods (see Fig. 2).

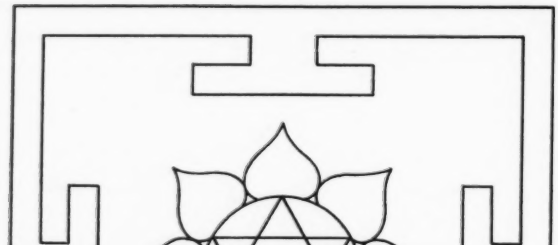
Healing Associations.

Some less well-known uses of sand may now be mentioned. Sand is used often in much the same way as salt. S. Seligmann in his work on the Evil Eye notes that in northern lands, to cure a whining child a little bag of sand taken from a heap before a church-altar is tied round its neck. In Naples, he tells us, a little bag of sand is supposed to serve as a protection against the *jettatura*. In Cape Town, according to to S. M. Zwemer, the so-called Malay doctors put faith in sand or earth taken from Mohammed's grave. In a Navaho magical or religious ceremony sand is taken from the different parts of the sand-picture of the god and is rubbed on the corresponding parts of sick persons to heal them. In Ashanti, according to R. S. Rattray, the captains of the Ashanti army will halt at the Tano River and ask a blessing. The priest then calls the fish, which come half out of the water and lie on the sand. Here they are made to vomit sand and water into a brass pan, and with this the captains are sprinkled. Wallis Budge notes that the early Christian Father Petarpemotis used to bless sand which the people of Egypt mixed with their sterile soil in order to make their crops abundant. Among the Santals, a primitive race in Bengal, it is said that if sand is eaten in food there will be a good harvest. Such instances as these indicate a belief in sand as a protecting, healing, and fertility producing substance.

Fertility Symbol.

If sand is a fertility-producing substance it is not surprising to find it used in connection with weddings. At Knutsford in Cheshire it was an old custom at weddings to sprinkle the pavement of the streets with sand, and to draw on the sand various emblems. Old verses which have survived indicate clearly that with this sanding was associated the idea of fertility. Again, at Newcastle-on-Tyne sand used to be strewn on the pavement for a bridal party to tread on. In Sunderland also sea-sand was used at one time for the same purpose, but afterwards sawdust served as a substitute. In Germany the same practice has been in vogue and still survives.

The sprinkling of sand on the floor of dwellings, houses, or chambers has been observed also. Among the Hausas, according to A. J. N. Tremearne, when a new house has been provided for the use of the Bori or spirits, it is well censed, and sand is sprinkled upon the floor. In the Siwah oasis a mother, after the birth of a child, lies on soft sand for seven days. It has been noted that such beds of sand recall the resting-places scooped in the sand by the nomad Tûareg. When the mother leaves her sand bed, she changes her clothes, and puts on new ones. When I was in Calcutta the learned pundit, Mahamahopadhyaya Haraprasad Shashtri told me that the Indian writer Bhasa in his



SAND DESIGN USED IN INDIA IN THE WORSHIP OF THE GODDESS SAKTI.

drama " Pratima Natka " alludes to a curious custom in the cemetery of kings, whose bodies had been burned. Whenever notable people came to see the statues of the kings, the cemetery was strewn with sand from which all foreign matter had been removed.

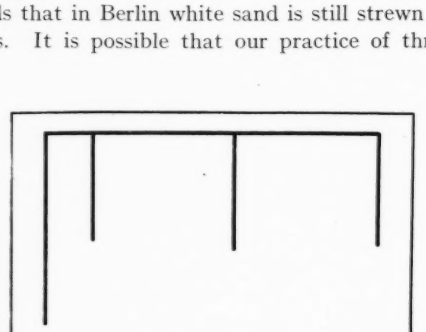
Unexplained Deposits.

The presence of sand on some sites has presented a great puzzle to ethnologists and archaeologists. The deneholes at Bexley contained, as noted by the Rev. J. W. Hayes, cones of sand consisting of three times as much sand, if not more, as could possibly have broken away from the shaft. Another anthropologist, Reginald A. Smith, has called attention to the presence of sand on some sites where flints have been found, and has remarked that this is not readily intelligible to the archaeologist. In his account of his excavation of Tell el Hesy for the Palestine Exploration Fund, Dr. F. J. Bliss says that in City iv the walls of the large building " were built in some cases on debris, in others on the walls of the lower city ; but a bed of fine yellow sand, half an inch thick, always intervened." The workmen, explaining by an ancient local tradition, said that the yellow sand was to prevent the walls from settling. This is not a likely explanation. Bliss says that without this clue of the yellow sand (which occurred only immediately under the walls, never extending into the rooms or outside the building), it would have been very difficult to trace the walls. In a building of mud-brick, which had five doorways, the doorways all had limestone sills, laid in a bed of about six inches of clean yellow sand. In City vii there was found near the east side " a curious stratification of fine, clear, yellow sand, covering an irregular space, seventeen feet by ten, on an average six inches deep. In some cases the sand overspread stone pavements." Before suggesting an explanation of this mystery, let me draw attention to some other significant uses of sand.

English Customs.

Deities are represented sometimes by figures of sand or by heaps of sand, and sometimes also as standing on a platform of sand. In the Flute ceremonies of North American Indians, two figurines, the Flute youth and the Flute maid, are set on small heaps of sand. Bishop Henry Whitehead noted that among village folk in South India the goddess Kurumbaiamma was represented by a decorated pot placed on a small platform of sand. On the seashore of Madras he often saw the village deity represented by a conical heap of sand, about three inches high, standing on a small platform of sand. According to Mrs. Sinclair Stevenson, the Hindu goddess Gauri is represented sometimes by five small heaps of sand. Parvati also may be represented by sand. When young girls worship Parvati, they go down to the river bank and make there heaps of sand which they call Parvati.

We have found that sand has been used in wedding ceremonies. It has been used also in funeral ceremonies. The *Folk-lore Record* reports a curious custom in Bristol, England. When an inhabitant of Back Street died, the whole surface of the street was covered from end to end with sand. The German ethnologist, Busse, to whom I have referred already, records that in Berlin white sand is still strewn round graves. It is possible that our practice of throwing



SAND DESIGN USED IN INDIA IN THE WORSHIP OF THE GODS.

a handful of earth into the open grave at a funeral is the survival of a practice of throwing a handful of sand.

If we turn now to a consideration of the actual disposal of the dead, we find that the use of a certain amount of sand is fairly extensive. Canon Atkinson, when he opened barrows on Cleveland moors, found that layers of white sand had been used in making the mound, and noted that the sand could hardly have been obtainable within seven miles of the site of the barrows. In an article on prehistoric graves in Germany, Busse notes that the skeletons were found to have been deposited on a layer of white sand. From this he infers that the custom of using white sand on ceremonial occasions goes back to the remote past—in this case to about 1000 B.C. But he does not attempt to explain the significance of the sand. In prehistoric graves in Scandinavia, according to Sven Nilsson, some of the skeletons were found sitting in a cell filled with sand, with amber beads round their necks. Other skeletons were buried in beds of sand about six inches in thickness. In the Kiev district of Russia, according to E. H. Minns, a tomb was found in which the wooden floor of the pit was strewn with white sand. Among the natives of the Florida peninsula the dead were buried in sand and earth mounds. In burials in Pueblo Bonito, according to G. H. Pepper, the skeletons were found to have been deposited on layers of yellow sand, or to have been covered with sand. In India the bodies of Hindus, as is well known, are usually burned. But, according to Mrs. Sinclair Stevenson, an ascetic is not burned, but buried. He is placed in the grave in a sitting posture, and is surrounded with salt and sand.

Egyptian Parallels.

The uses of sand among the ancient Egyptians have been left to the end of this article, because they seem to throw light on most of the uses mentioned above. The most ancient method of disposing of dead bodies was to lay them in the sand to a depth of three or four feet. In course of time it became customary to salt them first. When mummification was introduced, the body was placed in a bath of common salt. It was then packed with a mixture of earthy material, sand, and mud, and sawdust, or with sawdust alone. It may be noticed in passing that, as Dr. Elliot Smith has pointed out, the same use of sand is found among tribes of North American Indians. The floor of the ancient Egyptian burial chamber was sprinkled with sand, and the mummy or the portrait statue of the deceased person was deposited on a little raised mound of sand. We are told that one of the duties of the *shawabti*-figures, which accompany deceased persons to act as servants, was " to carry the sand of the East to the West," whatever that may have meant. In the Book of the Dead one of the magical names of Osiris, and consequently of the dead man, who was identified with the god, was " Osiris within his sand " or " Osiris on his sand " ; and the dead man is described as bowing down before Osiris and as exalting those " who are upon his sand." In ceremonies connected with reanimation, according to A. M. Blackman's account, sand figures again. In the Abydos Daily Temple Liturgy the tenth episode is " Performing the pouring out of sand." In a long inscription of the Ptolemaic period describing the funeral rites of Osiris, and implying the resurrection of Osiris, and referred to by Sir J. G. Frazer, mention is made of small images of the god, moulded of sand or vegetable earth and corn. We are told also that sand and barley were put in the god's " garden," which seems to have been a sort of large flower-pot. We learn that eventually the divine effigy was taken to a subterranean chamber and laid there on a bed of sand.

Probable Explanation.

When bodies were buried in the sand, whether accidentally or deliberately, it could not fail to be noted, particularly in Egypt, that the sand had a wonderful power of preserving them. J. H. Breasted, Wallis Budge, and Elliot Smith have observed that in the conditions of soil and climate in Egypt, dead bodies were preserved in the sand in a strikingly life-like state, and that such remarkable preservation of the human body can be found under natural conditions nowhere else in the world. It may be presumed therefore that this striking phenomenon suggested, at any rate to the ancient Egyptians, that in burials and in ceremonies connected with the dead, even when they became more elaborate, the use of sand in one way or another must be retained. No doubt this magic potency of sand was noted in other regions as well, if not to the same extent. In any case, we can understand the idea arising that sand, like salt, protects against corruption. Then would follow the further ideas that sand, like salt, preserves life, gives new life, wards off evil influences, has healing virtues, promotes fertility, and brings good luck. These ideas explain the use of sand in both wedding and funeral ceremonies and in healing rites. They explain perhaps the layers of sand noted by Dr. Bliss in the cities unearthed at Tell el Hesy. In this case, the sand would protect the buildings against evil influences, and bring to their inhabitants good luck and long life. They may explain also the sand found in the deneholes at Bexley. These deneholes may have been used either as burial chambers or as store-chambers for sand used in burial and other ceremonies.

Wireless and the Upper Atmosphere.

By R. H. Barfield, M.Sc.

The influence of the atmosphere on wireless waves of different length has provided physicists with problems not yet solved. Theories have been advanced, but much remains to be done before we can reach a thorough understanding.

WHEN Marconi had completed his first successful experiments, which showed that the electric radiations discovered by Hertz could be used as a means of communication over considerable distances, and finally in 1902 succeeded in bridging the Atlantic, attention was immediately directed to the problem of establishing the theoretical laws governing the radiation of wireless waves over the earth's surface. The results of this analysis indicated that the spherical form of the earth, intervening between the transmitter and receiver, should—in spite of diffraction—be too great an obstruction to enable communication to be established at all over long distances.

Lack of Data.

Here then appeared an uncomfortable divergence between theory and experiment but, owing to the lack of accurate measurements and to certain complications of the theory, which produced considerable divergence of opinion among the many eminent mathematicians at work on the problem, the exact extent of the discrepancy was not at all certain. It was necessary to wait, on the experimental side, until 1909, when Austin made a large number of measurements on the strength of signals received at various distances from a fixed transmitter, and on the theoretical side until 1912, when Professor G. N. Watson, after a critical examination of the results of other workers both theoretical and practical, produced a satisfactory and generally accepted theory of the propagation of wireless waves over the earth's surface. Austin's experimental results emphatically confirmed the existence of the discrepancy when compared with Watson's theoretical values, and all subsequent measurements made since over long distances lead to the same conclusion. In some cases the intensity measured is a million times greater than that which theory would predict.

Nothing remained but the virtual certainty that one or more of the assumptions made by the theorists was invalid. Apart from those underlying Maxwell's electromagnetic theory—for these one would refrain from questioning at least until the last resort—the only important assumption made, which could not be verified by simple experiments, was that the earth's atmosphere had the properties of a homogeneous and perfect dielectric.

It is true that those parts of the atmosphere which we can explore, that is, to about ten miles up, are known to satisfy this assumption well enough. But of the vast regions above this, into which the highest sounding balloon has never penetrated, we know little or nothing. It is natural, therefore, that speculation should turn to this part of the atmosphere to find a cause for the unexplained phenomena of long-distance transmission by wireless.

As early as 1900, in fact, Oliver Heaviside put forward a tentative hypothesis which is sufficient to account for the discrepancy. He postulated that the atmosphere at heights of the order of 60 miles is highly ionised owing to the extreme attenuation of the gases, coupled with the much greater ionising power of the sun's rays to be expected at such heights; and that this highly ionised part of the atmosphere forms a conducting medium which is bounded on its lower side by a fairly well-defined surface. At this surface, therefore, wireless waves arriving from below would be reflected or refracted, and thus returned to earth. The consequence of such a state of affairs is easily seen; for the waves, instead of escaping from the earth, would be confined in a comparatively narrow space between two concentric surfaces (that of the earth also being of good conductivity). Thus concentrated, the waves would naturally arrive at any given spot—sufficiently far from the transmitter for the upper layer to have full effect—with much greater intensity than if the layer did not exist; for, in addition to concentrating the energy, it would be the means of enabling the waves to bend round the curve of the earth.

Recent Developments.

Within the last few years the "Heaviside layer" theory has come into very great prominence, for the natural course of development of wireless telegraphy has brought to light a number of new and striking phenomena which cannot be explained without it. The advent of broadcasting has for the first time

brought about the establishment of a number of transmitters working at regular times and for long periods together on wave-lengths considerably shorter than any of those hitherto in common use, and thus has opened up a new portion of the wireless spectrum.

Those who attempt to listen in to a distant broadcasting station say, 100 miles or more away, have all now become familiar with the phenomenon known as "fading"; that is, the curious and rapid fluctuations in the intensity of the signals received. At one moment they may become faint and scarcely audible, at the next they will swell to an intensity rivalling that of the local broadcasting station itself. If, on the other hand, the same station is "tuned-in" in the middle of the day, it will be found that either it is impossible to pick up the station at all, or its intensity will remain quite steady. This phenomenon, though it will probably long be a serious hindrance to long distance broadcasting, is of particularly scientific interest, since it supports strongly the theory of a reflecting layer in the upper atmosphere. In the first place it is almost beyond doubt that no change takes place at the surface of the earth between day and night which could possibly cause a steady day intensity to change to a fluctuating night one, and in the second place, we know of no variation whatever in the physical state of the earth or known part of the atmosphere which could possibly bring about the rapid fluctuations in intensity characterizing the phenomenon.

Wave-length Effects.

We are then forcibly driven to look for the cause in the upper atmosphere, and the Heaviside layer supplies us with one. For if there are waves which travel from transmitter to receiver by an upper route as well as a direct wave travelling over the earth's surface, we have all that is necessary to give rise to the phenomenon of optical interference, that is, the adding or subtracting of the two waves according to their relative phases. Further, since we have no reason for denying the possibility of rapid changes taking place in these upper regions, we may suppose that the rapid fluctuations known as "fading" are due to interference effects produced by variations in the phase or intensity of the upper wave relative to the direct wave.

But broadcasting has led, if indirectly, to other interesting developments supporting the idea of an upper reflecting layer. The monopolization by this interest of the lowest band of wave-lengths hitherto in use has driven the experimental amateur to yet lower wave-lengths on which there had been little or no experience under modern conditions. These short wave-lengths, though accepted somewhat grudgingly by the amateur as the leavings of the more powerful interest, have proved to them veritable blessings in disguise.

No sooner had this allocation been made than rumours of unusually large ranges obtained by amateurs on certain occasions were current. Organized by amateur societies, a determined attempt was made to verify them and test the capabilities of the new wave-lengths. This led first to the successful establishment of communication across the Atlantic by many amateurs in 1921, and finally, in 1924, to the exchanging of messages between amateurs in England and their associates in New Zealand, employing in some cases the very modest amount of power of only 12 watts—an amount which it was believed by many would not suffice to carry more than a few miles.

Long-Range Transmission.

This truly astounding result seems hardly yet to have been realized. To work satisfactorily over a mere 2,000 miles, it has hitherto been found necessary to erect a station with an output of five hundred kilowatts and pass into the aerial a current of some 500 amps. Yet we now have amateurs working to each other across half the world every day with less than one ten-thousandth of this power and with the feeble aerial current of perhaps $\frac{1}{4}$ amp. in the aerial. It must be added, however, for a full understanding of the situation, that short-wave communication over these long ranges with such low power is decidedly freaky—in fact, it is usually only possible at all during a very few hours in the twenty-four. What is important here is that its possibility places it beyond question that the signals travel through the upper atmosphere and not along the earth's surface. It is well known that waves of this length when travelling along the earth are reduced to an insignificant fraction in a very few miles (hence the reason that they have so long been considered of little or no use.) An upper travelling ray is therefore the only possible way of explaining how it is they manage to escape being absorbed by the earth.

There is yet another phenomenon encountered in wireless telegraphy, only recently established as being of constant and regular occurrence which is closely connected with the problem under discussion; as is well known, it is possible by employing as an aerial a simple rotating coil of wire, to determine the direction of arrival of the waves received. This is called a wireless or radio direction finder, and is employed

to a growing extent for the navigation of ships and aircraft. Under normal conditions this apparatus is surprisingly accurate, it is quite commonly correct to within one or two degrees. When working over a long range, however, particularly over land, the apparatus records large and rapid apparent variations in the directions determined, making it appear as though the waves had been bent sideways many miles out of their straight course. But this effect is almost entirely confined to the night time. Now, just as in the case of "fading," there is absolutely no known factor at the surface of the earth which varies to an extent in any degree capable of producing variations of the magnitude commonly recorded; so as before there appears no other possible alternative to the inference that it is the variation of factors high up in the unexplored regions of the atmosphere which are responsible for the effects observed and that, therefore, waves must be involved in the phenomenon which have travelled to the receiver by an elevated path.

Investigations.

To endow unknown regions with properties so rapidly and strongly varying, that they are capable of deviating waves more than 90° out of their true path, must seem very unsatisfactory if we had to leave it at that. Happily there is no need for this. It is only necessary to assume that a rotation of the plane of polarization of the upper travelling wave takes place, to account for errors of any magnitude being recorded on a radio direction finder. For such apparatus goes completely wrong in the presence of waves travelling at an inclination to the horizontal and which are also polarized in a plane at right angles to their normal plane.

A number of well-established and commonly occurring phenomena in wireless telegraphy thus leave it almost beyond doubt that in a large number of cases an important part of the waves travel from transmitter to receiver by passing through the upper atmosphere at a height at least greater than 10 Km. above it, and we may now turn our attention to those investigations, theoretical and practical, which have aimed at more completely elucidating the mechanism involved in this phenomenon, or of determining more exactly the path which these upper waves take.

At first it was common to picture a reflecting layer to exist, consisting of a sharply defined conducting surface which acted in much the same way as a mirror. This rather crude idea, extremely difficult to account for on physical grounds, was greatly improved on by Eccles, who proved that the mere presence of ions in the atmosphere such as might be produced at high altitudes by the direct action of the sun might bend or refract the upward travelling rays from a wireless source back to the ground again, and that further the plane of polarization of these waves might be rotated by the action of the earth's magnetic field in the manner required by the explanation given above of the cause of errors encountered with direction finders. Larmor has recently considerably advanced Eccles' theory in probability by considering the action of free electrons on wireless waves, showing that these could certainly cause a very marked refraction of the waves without giving rise to much loss of energy during the process, while still further progress has recently been made by Appleton and Barnett in England, and Nicholls and Schelling in America, who have shown more definitely and convincingly than Eccles that the earth's magnetic field is likely to cause a rotation of the plane of polarization of waves travelling through the upper atmosphere in the presence of free electrons.

On the practical side, some brilliant experiments have been carried out by Appleton and Barnett early in 1925, in which they showed how the intensity of the signals at the receiver might be purposely varied by controlling the interference effect between the surface travelling wave and the upper travelling wave. The effects were produced by varying the wave-lengths of the transmitter, thus causing a variation of the number of wave-lengths contained in the path difference between the two waves. From these experiments they were able to estimate the height to which the upper wave travelled before being reflected down again.

Recent Results.

In 1922-23 the Marconi Company sent out two expeditions to make measurements of radio phenomena over large distances. The results obtained are extremely important, and have been described in a paper communicated to the Institute of Electrical Engineers; the masses of experimental observations on the strength of signals at various parts of the world, contained in this paper, constitute an overwhelming proof of the importance of the rôle played by the upper atmosphere in guiding the waves round the earth and preventing the energy from being lost in space.

CAMPHOR CULTIVATION IN SARDINIA.

JAPANESE camphor has long been known as the purest and, commercially, the most important. Experiments in Sardinia with Japanese plants from Formosa, however, indicate that camphor can be grown successfully in Europe.

Should Scientific Research be Rewarded?

By J. B. S. Haldane.

Pure science is economically unprofitable to the individual. The difficulty of assessing its value is obvious, and the problem is not likely to be solved until all scientific work is recognized as a public service to the State.

It is a commonplace that the wealth of modern societies is in a large degree the creation of scientific research, and it is therefore often suggested that scientific workers should share in this wealth on a scale more or less comparable with that on which labour and capital are rewarded. In particular, Sir Ronald Ross has for some years supported the idea that scientific workers who have made important discoveries should, as a routine, receive pecuniary rewards from the State—of course, the State—on a scale comparable with those of successful generals.

Unremunerative Research.

At first sight the justice of his contention seems clear. In other intellectual occupations—for example, literature, music, and the fine arts—those men and women who are most highly esteemed by their contemporaries enjoy fairly large incomes. A scientist can practically never hope to earn as much as £2,000 per year as such, and is generally glad if he gets half that sum, while incomes of £300 are quite common. To make more he must go out of the path of pure research and teaching, and apply his talents to industry, administration, popular writing, or some other activity for which there is an economic demand. Very little can be made by taking out patents. One cannot patent a new fish or a new star, and medical etiquette rightly forbids the patenting of a new medicine or a new surgical instrument. The physicist and chemist cannot patent their great discoveries, for two different reasons. In the first place they do not know how they will be applied. When Richardson discovered the laws governing electron emission from hot metals, he did not, presumably, suspect that he had made wireless telephony practicable. He could not take out a patent for all possible applications of his discovery; and many equally fundamental facts elicited at about the same time—for example, the emission of electrons by radioactive bodies in the cold—have found no paying application as yet.

Again, as a general rule, the greater the discovery the longer the time before it is applied. It was a long time before Faraday's discovery of electro-magnetic induction could be applied to the manufacture of a practical dynamo. He did not make a penny out of it and, fortunately, his heirs-at-law are not still being paid for it, as are those of Nelson for the Battle of Trafalgar. The Chinese might regard it as equitable that every user of electric light or power should burn at least one currency note per year before Faraday's image; and even a posthumous reward is better than none.

The French, for example, do not pay their men of science a living wage. On the other hand, they give them statues—often very good statues—when dead, and call streets after them. And to many scientific men, such is our perversity, the prospect of becoming a street name is a better incentive to effort than a rise of salary.

The greatest difficulty of a scheme of rewards during life is to be found in the impossibility of estimating the importance of a discovery until the discoverer is dead or too old to enjoy the money. Any jury will inevitably tend to rate the discovery of a fact above the invention of a method of research. Let us take as an example the recent and thoroughly justifiable award of a Nobel prize to Banting and Macleod for the preparation of insulin, the substance by whose injection a victim of diabetes can be restored to health. The numerous extracts prepared before success was reached had all to be tested by injection into dogs in order to study their effect on the amount of sugar in the blood. Now, accurate blood sugar analysis is extremely difficult, especially when one has only a few drops of blood to work on. It has been brought to its present degree of efficiency by some sixty years of very persistent and rather dull work in hundreds of different laboratories. This work had occupied far more time, and probably required far more thought and patience, than the final stage at Toronto. But its value was less obvious at the time and its appeal to the imagination is smaller.

Unrecognized Leaders.

As a matter of fact a great scientist is very lucky if in his own day he receives such recognition as a Nobel prize. Willard Gibbs, the father of modern physical chemistry, was probably the greatest American scientist of the nineteenth century. He was so far recognized by his contemporaries as to be made a professor, though I cannot believe that his lectures were very intelligible. His sister habitually compelled

him to drive her round in her buggy on the ground that her husband was a business man and could not spare the time.

But the fact that under a system of rewards much merit would be unrecognized is the least argument against such a system. No conceivable system can forestall the judgment of posterity. It would tend to divert scientific effort towards the obtaining of sensational rather than solid results. If a prize of a million dollars had been offered fifty years ago for a substance whose injection would relieve diabetes (and insulin would have been very cheap at the price), many of the men who devised the methods of blood sugar analysis would have been drawn into fruitless attempts to isolate insulin.

Higher Salaries.

Again, no chemical discovery is more obviously worthy of recompense than that of a new element. Three new elements—hafnium, masurium, and rhenium—have been discovered in the last three years. But in each case the discovery was made through the application of Moseley's law connecting the X-ray spectrum of an element with its atomic number. This law was arrived at as the result of a series of very careful and laborious measurements, which furnished the chemist with a weapon of enormous power. But I do not suppose that it was considered worthy of a paragraph in the popular press at the time of its discovery, and I doubt if the public would stand the allocation of large sums from its exchequer as a reward for work which is unintelligible to it.

Scientific discovery should be paid for on a system of credit rather than of cash down. At present research in pure science is mainly performed by professors and lecturers at universities in the intervals of the teaching and administration for which they are paid. A little research of this kind is paid for as such by the Medical Research Council and other public bodies, but the vast majority of the public money spent on research goes out for work on various branches of applied science, such as aeroplane design and practical medicine. The Royal Society has established a few professorships wholly devoted to research work, and one cannot but hope that many more such will be founded. A great discoverer can generally expound his own work, but he may be a thoroughly bad elementary lecturer and an extremely incompetent administrator of a laboratory. It would be an advantage to education as well as to research if these duties could more often be separated.

And everywhere the salaries are extremely low. It is too late to reward Faraday, Hertz, or Pasteur. We can at least see that their successors possess an income large enough to allow them to bring up a family of five children and give them a first-class education, while allowing themselves such luxuries as a small motor-car. I can think of no professorship in Britain or France which satisfies this criterion. Our research workers are faced with the choice of deserting their calling on marriage or drastically limiting their families. I can think of some who have become expert witnesses, journalists, civil servants, and even tobacco salesmen, to their own economic advantage, but hardly to that of posterity. Others content themselves with one or two children, a questionable advantage to the public since scientific ability is strongly inherited.

There is, perhaps, a final argument, from the point of view of the scientist, against a system of rewards for research, namely, that it should logically imply a system of punishments for discoveries adjudged to be of disadvantage to the public. The discoverer of a new explosive, a new poison gas, or a new principle in aeronautics, might find himself or herself condemned to the most appalling penalties. Such discoveries are often made by persons of the mildest character, who have no idea that their work will serve to kill a fly, much less a human being. And as it is equally true that discoveries of immense general utility are often made by misanthropes only interested in pure theory, and caring not a rap for their own nor anyone else's welfare, there is perhaps no injustice in refusing them pecuniary rewards which few of them have ever demanded.

But it is not only unjust but contrary to the public interest that scientific research should be, as it is, the worst paid of all the intellectual professions.

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RISKS OF NITROBENZENE INSECTICIDES.

It cannot be too strongly emphasized that children should be prohibited from handling insecticides. Most of these are of little danger so long as they are not taken internally. The trouble is, of course, that what goes into a child's hands almost inevitably goes into its mouth also. This is brought home by the recent poisoning of a child of fourteen by a desert-spoonful of insecticide found afterwards to contain nitrobenzene. Happily the child recovered after three weeks, since the toxic dose of nitrobenzene is relatively large.

Flint Implements.

By Eric W. Walford.

The spring rains expose on the surface of our fields quantities of flints. Many of these may be the working tools of prehistoric man. This elementary article is meant for the beginner who may be led by a casual find to a greater interest in the subject.

It is possible that man owes his very existence to flint and, if it were not for this substance, he would never have become an intelligent being and he would have been lacking even the means for making fire. Add to this that it is practically indestructible and is harder than steel, and it is evident that the material itself, and the way in which it was used in man's early days, merit some consideration.

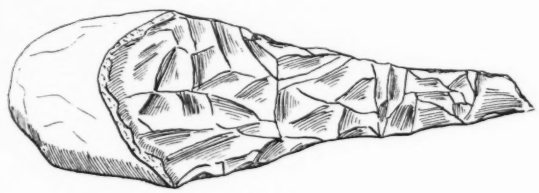


Fig. 1.
A TYPICAL SHAPED COUP DE POING,
about 14 inches long.

The man animal, a sort of cousin of the monkey animal, probably started his wonderful development merely as a consequence of his picking up and holding in his hand a heavy stone when fighting, using the stone hammerwise. (One of the oldest types of weapon found is the "coup de poing," a longish stone, not necessarily of flint, to be held in the hand.) Then the man animal would find that stones with sharp edges or corners were more successful. This started the process of selection which would lead him on to searching for stones which had durable edges *which kept sharp*. The next step would be to endeavour to improve the stone, to create the sharp edge, or to resharpen it.

Flint and Pyrites.

In time he would discover that these sharp edges were useful for cutting up food, assisting in the making of his habitation, and later in preparing clothing. Hence his final selection of flint.

It is therefore easy to see that cutting edges were essential to development. Without such stones capable of retaining sharp edges man could not have got beyond the "coup de poing" stage, and would not have been able to provide himself with clothing nor, probably, have developed into a successful carnivorous animal.

It will be agreed that, in the early stages in his evolution, the ability to produce fire would have still further elevated man above other animals. Now, in searching for flint, which is found in chalk, he would find, also lying in the chalk, some very heavy lumps of (apparently) stone which would appear to be handy for hammering the block of flint. This heavy material, iron pyrites, when struck on flint, produces sparks and so, quite accidentally, he would find himself able to produce fire. Was it by chance only that man was able to find these two fire-producing materials side by side?

Three Groups.

The few stones other than flint used for implements are so scarce that they do not affect my contention that flint was essential to man's evolution.

Flint tools and flint implements are found over the whole world, not only where the material is indigenous, but also in places where it is not naturally found, except possibly in small pebbles in rivers, gravels, or other drift.

Fig. 2.
A ROUGH FLINT KNIFE,
still capable of sharpening a pencil.

Flint implements are at present divided into three chronological groups:—

(1) *Eoliths, i.e.*, very crude implements used at the dawn of the Stone Age. These are the oldest at present recognized, though it is highly probable that there are other types of implements very much older.

(2) *Palaeoliths*, used during the Palaeolithic era; roughly speaking, as regards this country, the time before the last Ice Age. It is impossible to assign a date to these, but anything prior to ten thousand years ago, and possibly as far back as half a million years, is a rough notion

of the duration of the Palaeolithic era as regards this part of the world.

(3) *Neoliths.* After a very long interval (as regards this part of the world) subsequent to the Palaeolithic age, there appeared another race of man who also provided himself with flint implements of a more refined type than the Palaeoliths.

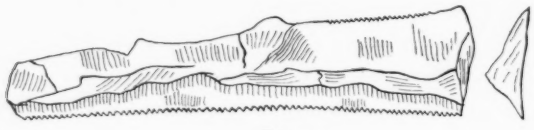


FIG. 3.
A VERY FINELY TOOTHED SAW.

Eoliths roughly resemble largish broken flint pebbles very slightly chipped and roughly shaped into forms which suggest their suitability as "coups de poing" and for other simple usages. Palaeoliths show finer working and better formation (see Figure 1, which shows a Palaeolithic coup de poing). Eoliths have only been found in drift beds of gravel, etc., formed during and after one of the earlier glacial periods. The same applies to a great extent to palaeoliths, but many of the latter have also been found, probably on their original sites, in caves and on palaeolithic beds, *i.e.*, levels which were probably the surfaces of the earth during the Palaeolithic era. However, it is rarely that a palaeolith is found anywhere near its original site, these implements being discovered generally in gravels, etc. Fortunately, some implements are found in caves and on a few palaeolithic floors which help one to form a rough idea of the habits and culture of their users.

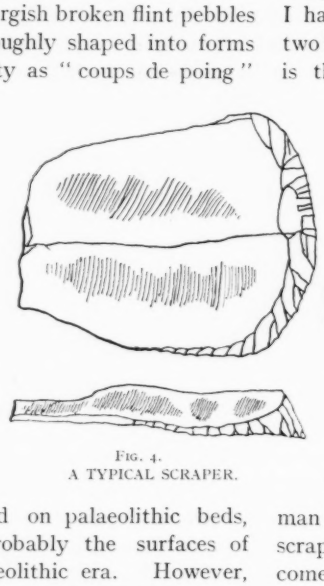


FIG. 4.
A TYPICAL SCRAPER.

FIG. 5.
A TYPICAL BORING TOOL.

Rough Tools.

Neoliths, on the other hand, were used much nearer to our present time, say, anything from 10,000 to 3,000 years ago, and they are found in what are undoubtedly the sites of occupation of their owners. Often they are ground or polished quite smooth, but most of the smaller neolithic flint tools are rough.

We have been able to learn quite a lot about the methods of construction of neoliths, whereas, for the reasons above stated, little is known of the two earlier types. The probability, however, is that a good deal of what applies to neoliths also refers to palaeoliths, if not the still earlier ones.

Material Economy.

Flint (except in river pebbles or other drift) is only found in association with chalk, and, as everybody knows, chalk is confined to only a small area of this country. Flint implements, however, may be discovered pretty well anywhere in England, but obviously in very much larger quantities in the chalk and flint districts. Where chalk and flint are not indigenous, the implements are smaller and are clearly made from pebbles. For example, in exploring earthworks some sixty miles from the nearest chalk and flint country, I have rarely found a single implement greater than two inches in length, and what is particularly noticeable is that nearly every fragment of flint was shaped or chipped so as to be of practical use as a cutting or scraping tool. Another striking point was that the shaping and chipping was the minimum necessary to make the fragment into a useful tool.

People who do not study the subject imagine that flint implements are confined to axes, arrowheads and spearheads, but a little consideration will make it clear that neolithic man must have provided himself with cutting and scraping tools, and the majority of implements come into the latter classes, but are generally overlooked by the inexperienced, who are hunting only for nicely shaped arrow and spear heads.

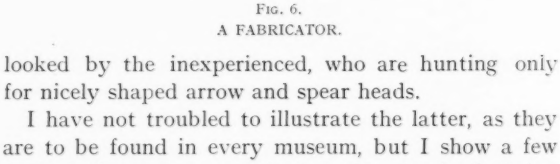


FIG. 6.
A FABRICATOR.

I have not troubled to illustrate the latter, as they are to be found in every museum, but I show a few typical flint tools, a crude but effective knife being depicted in Figure 2. This is a flake of flat triangular section of about four inches in length, picked up on a ploughed field three miles from Coventry, and it is in such a condition that with it one can still sharpen a pencil. As I have tried to show in the illustration,

there is no grinding, chipping, nor any secondary working. It is merely a flake struck off a block in such a way as to produce a very sharp cutting edge. How this was done will be described later.

The third illustration shows a similar kind of flake, very cleverly nicked along both edges, one side being very noteworthy. These nicks are about a millimetre apart, or 25 to the inch, and the result has been to produce a very delicate and sharp-edged saw. This is an extremely fine specimen of flint saw, and I am indebted to Mr. S. Sanders, of Kenilworth, for the loan of it. It was found by him in Yorkshire. I have seen many other saws, but the nicking is generally much more crude, though the form is obvious.

The most general type of implement, and the one most easily overlooked, is the scraper. These presumably were used for scraping skins, bones, etc., and as spokeshaves for shaving arrow shanks and kindred purposes. Seeing the large number that are found they must have been extremely useful. In Figure 4 I show a scraper which was used somewhat in the way in which one would use a safety razor blade for scraping paint off woodwork. It is just a flake of flint, about three-eighths of an inch thick, with the cutting edge bevelled off so as to leave a nice sharp strong corner. There are many other types of scraper, but space does not permit me to deal with more than one.

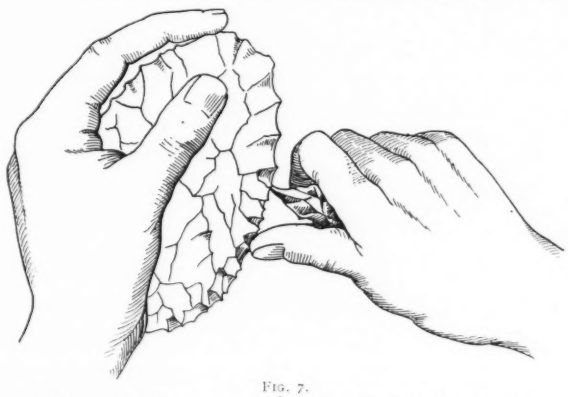


FIG. 7.
HOW A FABRICATOR WAS USED TO CHIP AND SHAPE AN EDGE.

Flint borers must have been much more difficult to make. They consist generally of a flake trimmed to as sharp a point as possible (see Figure 5), and sometimes one or more of the other edges of the flake is chipped to form a scraper. This chipping of the edges was formed by means of a fabricator (shown in Figure 6), and the method of using it will be clear from Figure 7.

Pigmy Implements.

There is a very pretty type of implement found in certain localities in this country called "pigmy flints." These are exact copies of the normal-sized flint made in miniature. For example, there may be arrowheads and spearheads of from a half to three-quarters of an inch in length, all most beautifully produced, but with what object nobody has been able to suggest. Samples of these pigmy flints can be seen in many museums. I am inclined to think that they were produced in districts where flint was very scarce and only found in the form of river pebbles, and that their owners had to make the most of the little material they could find.

Flint Mines.

In chalk-country flint nodules are to be found all over the surface, but neolithic man generally turned up his nose at these and went to the trouble of sinking shafts thirty feet in depth so as to strike a vein of flint blocks of better quality. These flint mines have been discovered in more than one place in England, but the most famous are known as Grimes' Graves, near Brandon, Suffolk. Here the shafts communicate with radiating galleries, and in them have been found samples of the stone lamps used by the original workers, and original deerhorn picks with which the flint was mined. (These deerhorn picks have often been found in earthworks, and they consist in antlers of the red deer with all but the brow tines removed. The latter forms the pick proper, and was probably fixed to a shaft.)

The flint found in these veins is in large blocks eighteen inches to two feet long, and it is of a very much finer quality for producing implements. Curiously enough, there is still a flint industry at Brandon in Suffolk, which has possibly survived without a break from neolithic times, and may rank as the oldest industry in the world to be continuously operated. The modern flint worker gets his flint from the same vein, twenty to thirty feet underground, and produces flakes identical with those found on neolithic sites.

To break flint with any accuracy it has to be supported on something yielding, and the present-day flint-worker puts a resilient pad on his left thigh and lays the block of flint on this. He first breaks the block up into pieces more easily handled, an operation called "quartering," and he does this by striking the top of the block with a short hammer having a heavy head. The "quarters" break off almost as easily as glass and fracture very cleanly. If the block were supported on anything hard it would probably smash into a number of small fragments.

The small quarters are then split up into flakes (Figures 8 and 9). For this the resilient pad is removed and a plain leather pad substituted, and a hammer with a lighter head and a longer shaft is used. With this the block is struck near the edge, when off comes a long flake. In Figure 8 I have shown roughly how a quarter is broken up, and it will be noted that

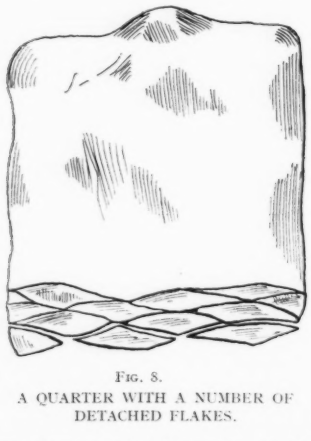


FIG. 8.
A QUARTER WITH A NUMBER OF DETACHED FLAKES.

the flakes are always of triangular or thin diamond section, and if this is compared with the knife in Figure 2 the resemblance will at once be seen.

This Brandon flint industry owes its survival to recent times to the use of flint-lock rifles, pistols, and tinder apparatus. Although all these have long since gone out of use in England, flint-lock rifles were bought up years ago and exported to places such as Morocco. There is even now a demand from the Moors for flints, and so this old industry at Brandon assists to maintain our export trade. In addition to this, flint and steel apparatus for producing fire is still used by explorers and many people abroad, so that it is possible that the industry may run on for very many years yet.

Patination.

Neolithic man used for the purpose hammer stones, which are often found in camps and earthworks. Furthermore, one finds the actual sites where flint implements were made, as is evidenced by the large number of nodules, wasters and chips. Sometimes these sites are discovered in districts far removed from natural flint, where large blocks must have been precious materials. In this connexion it is curious to note that the flint and chalk districts are now probably the poorest in the country, whereas in neolithic times they were probably the richest, owing to their possession of the invaluable raw material—flint.

Flint very slowly becomes glazed and surface-coloured, and this glaze (or patina, as it is called) is generally, but not always, clear evidence of the date of the implement. Although many people call all kinds of stone "flint," the true material is of a glassy nature, honey-coloured, dark brown, or black. When the flake is made it is, of course, its original colour, but when exposed to the air it tends very slowly to become white or straw colour, the change depending somewhat on the soil in or on which it lies. Generally speaking, the surface goes blue, then bluish grey, grey, and finally straw colour, cream colour, or pure white. One can therefore generally tell whether an implement has only recently been broken, or whether it is of its original shape. Some implements show signs of two sets of workings and different colours of the patina.

Begin Collecting.

I hope that the above brief description will enable readers not acquainted with the subject to take an interest in the different types of implement seen in museums, and possibly also to search for and recognize worked flints. Neoliths are still to be found in thousands on or within a few inches of the surface in chalk districts and in old earthworks, whilst deeper

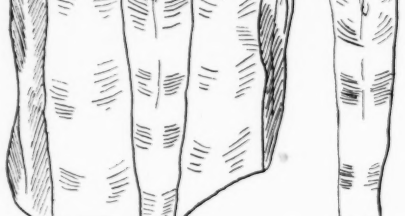


FIG. 9.
A QUARTER AND A DETACHED FLAKE, showing the curved ripples on its face.

down in gravel pits and drift deposits in the south of England may be found palaeoliths or even eoliths.

BRACKEN POISONS CATTLE.

THE County Analyst for Kent reports that investigation of poisoning among cattle revealed that these had eaten bracken. On opening the stomachs it was found that the animals had been eating this for some time past, and that in all probability the alkaloids in the bracken had acted cumulatively, finally killing them.

Ravens.

By E. W. Hendy ("Ernest Blake").

The raven is a bird of ominous and literary associations, but within memory they have become one of the scarcer birds. It is to be hoped that protection will enable them to increase.

RAVENS are now denizens of the wild. In times past things were otherwise. Though of late years they have at least maintained and perhaps enlarged their nesting range, they were, even up to the middle of the last century, far more common than they are now. Under present conditions their nesting site is usually on some seaboard or inland cliff face; the presence of "raven's trees" in many parts of the country commemorates the fact that formerly they were also tree builders; unpersecuted, they would certainly revert to their old habits. One instance of a tree nest has been recorded in England so recently as 1920, and I was informed of another similar nesting-place in 1925, but its locality is wisely kept a secret. I know well another raven's tree, the "noble beech about ninety feet in height" mentioned by Bishop Stanley in his "Familiar History of Birds." He relates how one of the pair of ravens—the female—which nested in this tree, was shot when the young were nearly fledged; the surviving parent procured a new mate, whom he brought to the old nest; she proved a cruel stepmother, for she attacked and threw the first family out of their nursery; she must have seemed to them to have a "damned disinheriting countenance." Two of them were picked up alive, reared at the rectory, about a quarter of a mile away, and subsequently pinioned. Even their father's heart was turned against his own offspring, for both old birds would attack the young ravens in their new quarters if they found them unprotected.

YOUNG RAVENS IN THE NEST.
[*Photo by Mr. Cox, F.Z.S.*

Distinctive Croak.

Fortunately, if one knows their haunts, it is still possible to observe these noble birds in their wild state. Probably the first news of the raven's presence will be a deep croak; it is usually rendered "glog," but, to my ears, at any rate, the labial is hardly audible; the guttural element is what arrests attention; I should describe it as something between a snore and a bark. The note is extraordinarily resonant; it carries an immense distance, being distinctly heard when the bird is flying at a height so great that, but for its distinctive call, its identity would be doubtful. Breaking unawares upon the stillness of moorland spaces, or amid the silences of a lonely mountain pass, its effect is awe-inspiring; it has a *timbre* which is at once human and supernatural, as though some disembodied spirit were warning the intruder to refrain from violating by his presence a hallowed spot. Reverberating along rock-bound cliffs, from whose distant base the sullen roar of breakers booms incessantly, its effect is not less startling. One can hardly be surprised to find the superstition, that the raven's croak presages death, still surviving. Only a few years ago an old dame solemnly assured me that she had found by experience, and that recently, that the belief was a true one. Other calls, used often in moments of excitement or alarm, are a harsh "arrhk, arrhk," and a shorter note, like the bark of a terrier.

Mating Season.

When the yet-distant footsteps of spring can scarcely be caught by human ears, love's young dream comes to the raven. At such a season, either just after dawn, or shortly before sunset, you may watch him sailing high above you. Suddenly he turns over on his back, careens forward for a space, then rights himself again, and chuckles—"tootle-oo." That a bird who is capable of emitting, on other occasions, such awe-inspiring sounds, should descend to a remark which seems banal, may look like bathos. But the

explanation perhaps is that, like all the crows, he has a strain of humorous devilment in him. His summersault is an ebullition evoked by varied feelings: it is part love, part exhilaration, and part pure fun; and so his comment on his own aerial acrobatics is, in tone, both tender, boisterous and humourous. Pepys would have called it "roguish."

Sometimes, when sailing into a stiff breeze, the summersault is used as a perhaps involuntary method of alighting on the ground; turning slightly across the wind, the bird seems to be blown over; at any rate on such an occasion his landing, with sprawling legs and claws, and wing quills fully extended, is anything but graceful. How powerful are the strokes of his great wings I realized one day when I was sitting on the lee side of a rocky escarpment; one raven flew over me at some height, and then a minute later another, flying lower, was just above my head before my presence was suspected; so close that I could see the "beard" formed by the long throat feathers. The whirr of the great wings, as the bird swerved upwards and outwards, was like the flapping of a sail. He has yet another note, which resembles the "honk" of a Canada goose, or a ventriloquist's imitation of a distant motor-horn. This call is sometimes used by another raven in reply to the "glog" croak; possibly it may be the hen's answer to the male, but this is a surmise which requires verification.

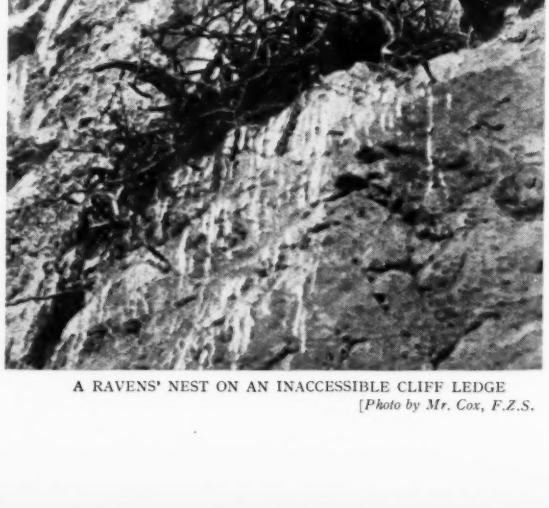
Cliff Nest Site.

The early days of March or even February find ravens busy nest-building; a pair I watched this spring were carrying sticks and sheep's wool on 6th February. The site chosen was on a cliff ledge, only a few yards distant from the battered remnants of a previous nest. In moments of relaxation from their constructive labours they would settle near each other on a grassy slope at the cliff top, and indulge in a bout of billing, but not cooing—dismal croaks took the place of that. One bird, presumably the female, shivered her wings after pitching near the other. They were shy of coming to the nest while I was watching, though I was concealed and at a considerable distance from it. If one were absent, the other kept a suspicious eye upon me the whole time. The sentinel, on the return of his mate, gave four sharp croaks of warning. Their meaning, "man, man, man, man" was obvious; in the midst of her final sweep down to the nest, the returning bird swerved and settled some distance above it: the ensuing conversation I gathered to be uncomplimentary to the human race in general, and to me in particular. The watcher varied the monotony of his sentry-go by soaring into the wind, diving and side-slipping, but even during these evolutions he did not forget my presence; I could see him turning his head to keep his eye upon me as he flew. At times both birds would sail together, rising and falling above and below each other, and then plane away in widely separated ellipses.

Young Brood.

This pair reared a brood of three sturdy young ruffians. When they were near the end of their fledgling period I could, when standing on the beach below, watch them climb upon the inner margin of the nest, and crane their necks to look at me with black eyes, in which mischief and suspicion were mingled, after the corvine fashion. Though down was still adhering to their breasts, their wing and tail feathers were well-grown; they would stand upon the edge of their cradle, and flap their pinions lustily, a form of exercise which showed that ere long they would be abroad with their parents and learning the playful wickedness which is the badge of all their tribe.

Sometimes the ravens' nest, bulky structure though it is, fails to last out the five weeks' fledgling period, and falls to pieces before the young are ready to shift for themselves; its disintegration is probably hastened by the scrabblings of its occupants and the buffetings of the spring gales; a nest which I had under occasional observation last year met with this fate. Visiting the site after a month's interval, I found that



A RAVENS' NEST ON AN INACCESSIBLE CLIFF LEDGE
[*Photo by Mr. Cox, F.Z.S.*

it had entirely disappeared. That the agent of its destruction was human is possible, but, from the inaccessibility of the site, not probable.

Even with ropes the approach to a ravens' nest is not without its difficulties. A tale (for whose truth I do not vouch) is told of a man who was anxious to secure a young raven from a nest built on the face of a steep and precipitous quarry. Some of the workmen let him down with ropes, but when he had negotiated part of the journey they found it was impossible to lower him farther; unfortunately, it was equally impossible to draw him up. In this quandary they sent to the owner of the quarry for instructions; his answer was "Let un 'bide." And "bide" he did for some hours until, eventually, he was hauled up into safety, but without his raven.

Carrion Feeders.

The ravens' taste for carrion is well known. Almost any morning one may see and hear them flying high from their haunts on the cliffs towards the moor; watch a dead sheep overcome by a March blizzard and, if properly concealed, you will see a pair or more of these black-coated gentry giving as much of the carcass as they can hold an indecent burial. Of their depredations on weakly lambs I can only speak from hearsay evidence. Some years ago I saw a nest in which were huddled the remains of the young, ruthlessly shot in reprisal for their parents' alleged misdeeds in the lambing season; it was a melancholy sight. One may often come across them among the hills, feeding on the ground where numberless beetles crawl and tumble helplessly; such food one does not grudge them. Following on foot the chase of the red deer I frequently hear the cry of hounds and raven in conjunction. Whether he scents blood and has hopes of carrion later, I cannot say; it may be so, but when hounds have had their share there are not many "unconsidered trifles" left over. I have seen ravens feeding on the beach, but too distant for me to ascertain what caused this curious excursion in marine zoology; no doubt the flotsam and jetsam of a tidal shore provides much that would tickle a palate which is never squeamish.

TWO CHINESE FIGURINES.

(*Continued from page* 58).

The persistence and prevalence of this type of features and head-gear from Achaemenid to Sassanid times shows that it was neither uncommon nor foreign in Persia. Our clay figures had their originals in Western Asia, possibly in Persia or—as it was in the time of the T'ang Dynasty—Parthia. The presence of Western Asiatics in China need not surprise us. An-hsi, the Chinese name for Parthia, frequently occurs in Chinese annals. The earliest reference is to the reign of the Emperor Wu-ti (140-86 B.C.), who sent an embassy there, and in return the Parthians sent ambassadors to the Chinese court with presents of birds' eggs and jugglers. In A.D. 87 they sent presents of lions and a "fu-pa," which the annalists describe as a hornless unicorn. In A.D. 101 they sent lions and ostriches. Thenceforward they are often mentioned as a powerful race who controlled, to their own great profit, the trade with the Far West.

China, under the T'ang emperors, was not a land closed to strangers. Christians, heretic and orthodox, made their way there from the West and found no opposition. Under the patriarchate of Timothy (A.D. 778-820), one David was appointed metropolitan of China; in 745 an edict of the Emperor Hiuan Tsung refers to the sacred books known as Persian and says they really came from Ta Ts'in, the Roman Empire; and the famous Nestorian stone erected in A.D. 781 shows Syrian Christians at work in the seventh and eight centuries. T'ang funeral pottery portrays other foreigners besides our type; the Eumorphopoulos collection possesses a figure who looks like a Red Indian, and there are several extant examples of a debased Greek type with curly hair. There is nothing improbable in strangers from the West.

We can only guess what they were doing so far from home. They were servants of some Chinese noblemen, and their gesture of obsequious servility points perhaps to their being butlers. When Confucius abolished the custom of human sacrifice at the death of any rich person, clay or wooden models of retainers were substituted for living victims, in the belief that they would attend to the wants of the departed. Our figures are of such retainers.

ROYAL METEOROLOGICAL SOCIETY.

By kind invitation of Col. H. G. Lyons, F.R.S., Director of the Science Museum, a meeting of the society, which will take the form of a conversazione, will be held in the new galleries of the Science Museum, Exhibition Road, South Kensington, on Wednesday, 3rd February, at 5 p.m., to see the Meteorological and Physical Collection.

A gallery which has just been opened contains a large and effective display of meteorological instruments and weather charts, both modern and historical.

Book Reviews.

Eclipses of the Sun. By S. A. MITCHELL, Director of Leander McCormick Observatory, University of Virginia. Pp. xvii + 452. 66 Illustrations. Second edition, revised and enlarged, 1924. (New York: Columbia University Press; London: Humphrey Milford. Price 25*s.* net).

This is the second edition of a book first published less than two years earlier. It is a remarkable tribute to the extent of its appeal that a new edition should be required so soon, particularly as the additional matter is very small in quantity compared with the rest of the book. The author is to be congratulated on the success of his effort.

One finds here as comprehensive an account of solar eclipses and their attendant phenomena as it is possible to conceive. No aspect of the subject seems to have been left untouched. There is an excellent account of historical eclipses and their use for chronological purposes. The methods of prediction and verification of eclipses claim two chapters, and then we are introduced to the actual phenomena which make a total eclipse of the sun so important an event for the astronomer. The spectroscope naturally comes up first for consideration in this connection, and the author not merely explains its construction and use but gives a clear account of the history of the instrument and its applications from the time of Newton onwards. An intelligent appreciation of the application of the spectroscope to solar problems involves a knowledge of the information about the sun which we obtain from other sources and this is faithfully given so that the reader may have, as it were, all the cards laid out before him. All the eclipses—from that which so impressed Tycho Brahe in 1560 to the eclipse seen in America in 1918—which have contributed to the progress of astronomy are then passed in review individually. One naturally expects this to be succeeded by an account of the eclipses subsequent to 1918, but a serious difficulty presents itself. Owing mainly to the Bohr theory of the origin of spectra, which was first put forward in 1913, and Einstein's generalized theory of relativity which was given to the world in 1915, the eclipses which have been observed since the conclusion of the great war have been invested with new interests, and problems have been attacked which did not exist before that time. Professor Mitchell is therefore faced with the task of making the character of those problems clear to his readers, and this he does in a most interesting manner in a discussion extending over several chapters. The ground thus being prepared, the eclipses of 1919, 1922 and 1923, are reviewed in detail, the chapter on the last-named eclipse being given for the first time in this edition of the book.

The comprehensiveness of the work is indeed its most striking characteristic. No knowledge of research in other departments of science is assumed on the part of the reader. When such knowledge is required it is given, and not merely referred to as being obtainable elsewhere. For that reason the book is useful not only for those whose chief interest is centred in solar eclipses, but also for the lover of science who requires an interesting and accurate account of particular subjects, such as the theory of relativity, Leha's ionisation theory, the structure of the atom, theories of the corona, and so on. Nor is even the aesthetic side of the subject overlooked. A total eclipse of the sun is one of Nature's most impressive spectacles, and we have heard of men who have travelled thousands of miles, not for astronomical observations, but to allow the spirit of the eclipse to enter into their souls. Professor Mitchell is, of course, primarily an astronomer, but he is not untouched by the wonder and beauty of the sights he has observed, and he has included a number of reproductions in colour of paintings made by Mr. H. R. Butler at various eclipses. Perhaps such reproductions do not convey much idea of the actual appearances observed, but the simple fact of their inclusion is a gratifying indication that the man of science is not always, as he is so often assumed to be, indifferent to the aesthetic side of Nature.

It is not generally realized that it is only by the most extreme and almost incredible good fortune that we can ever witness the precise phenomenon which we describe as a total eclipse of the sun. The bright body of the sun is surrounded by a relatively very thin atmosphere, the study of which is one of the chief objects of an eclipse expedition. This atmosphere can be studied to the best advantage only when the bright disc of the sun is completely obscured while the atmosphere itself is left exposed, and this requires an obscuring body whose limits of apparent size must cover a very small range indeed. It is our privilege to possess a moon whose diameter coupled with its distance from the earth gives exactly the right conditions for the observation. So nicely adjusted are the conditions that sometimes, when the moon is slightly farther from the earth than the average distance, a total eclipse is impossible; we obtain an "annular" eclipse, which from the scientific point of view is practically worthless. If the moon were never nearer to the earth than this we should know nothing of the existence of the corona or of much of the other information which eclipses have given us. On the other hand, if the moon were much nearer, it would obscure the solar atmosphere and a part at least of the corona, at the greatest phase, and we should again be deprived of many of the advantages we now possess. It is true that our privileges are accompanied by the disadvantage that totality lasts but a few minutes at the best, and is visible over only a small area on the earth's surface, but these are relatively minor disadvantages and can be overcome by patience and industry. "The author has travelled," says the introduction to the book, "nearly fifty thousand miles to witness five total eclipses of the sun. The total time afforded him for scientific observations during these five eclipses has been a period of about twelve minutes."

The book is written mainly for those who are interested in astronomical research without possessing the somewhat abstruse knowledge which the working astronomer now finds necessary. At the same time there are many portions—notably a critical discussion of the explanation of the observed deflection of stellar rays passing near the sun during an eclipse—which will be read with profit by even the best-informed astronomer. It is one of the author's main achievements, and goes far to account for the welcome which the book has received, that he has succeeded in writing a book at the same time completely intelligible to the layman and valuable for the practical worker. The style is most interesting throughout, and the author's account of some of his personal experiences on eclipse expeditions is made to blend admirably with the purely scientific matter.

Few living astronomers have had more experience in eclipse observation than Professor Mitchell, so that the substantial accuracy of his account goes without saying. A few errors are, of course, inevitable in a work covering so large a field. Thus, on p. 309, it is stated that no series have been found in the spectrum of manganese, whereas such series were published in a very important paper by Cortalan in 1922. Again, the statement on p. 284 that isotopes are indistinguishable by

spectroscopic tests is inaccurate in view of Mulliken's work on band spectra, and on p. 289 the distinction between principal, diffuse, and sharp spectral series is wrongly ascribed to relative intensity of the lines. Such slips, however, are of a trifling character in a work of this kind. Rather more serious is the occasional occurrence of explanations which are so condensed as to make it doubtful whether they are of any use at all. The account of spectral series, for example, is open to this criticism. But it must be emphasized that such passages are the exception and not the rule. It would not have been surprising, considering the scope of the work, if they had been much more numerous than they are. Taking the book as a whole, we have no hesitation in recommending it as one of the most interesting, up-to-date, and accurate accounts of solar research and allied subjects that have yet appeared. H. D.

Annals of Archaeology and Anthropology. Issued by the Liverpool Institute of Archaeology. Vol. XII. Nos. 3-4. November, 1925. (Liverpool University Press. Price 6*s.* per quarterly part).

Ancient Egypt. December, 1925. British School of Archaeology in Egypt, London. (Macmillan & Co. Price 2*s.*).

Among periodicals devoted to the study of archaeology few exceed in interest the two mentioned above. Both are distinguished by a certain originality and freshness in outlook and, it is hardly necessary to add, by a high standard of accurate scholarship. Further, although they necessarily deal with matter sometimes of a highly technical character, as each is primarily addressed to a specialist public, the treatment of such questions as a rule is such as to appeal also to those whose interest lies rather in the broader questions of archaeology.

In the current part of the *Annals of Archaeology and Anthropology* Mr. F. Ll. Griffith continues his descriptive catalogue of the results of the excavation of the Meroitic Cemetery of Faras, in Nubia, by the Oxford University Expedition. The stupendous task of recording the objects found in the excavations is now happily nearing completion. Students of the future will owe much to those by whom this heavy work has been carried out. The present section opens with a classification of the types of burials, the cave graves, side-niched burials, foot-niched burials, rectangular-bricked burials, and graves with superstructures, shrines, etc. These categories suggest some interesting inferences as to their progression and relationship, into which Mr. Griffith enters in some detail. The Meroitic period in the cemetery extends to somewhere about the end of the third century A.D. Intervening between this and the introduction of Christianity in the sixth century A.D. occur a number of contracted burials. Mr. Griffith makes the interesting suggestion that they represent an influx of barbarians, though it is curious that a preponderating proportion should be the graves of children.

An interesting example of the way in which a modern custom may offer a possible explanation of an obscure archaeological find is furnished by the tentative suggestion that a peculiar gold ornament of a type already known from a find in 1834 may be the ancient counterpart of a hair ornament given to the modern Barabra woman by her husband on her marriage.

Of the remaining two papers in this part, one by Professor A. H. Sayce deals with the identification of a Hittite geographical name; the other is an account by Professor J. P. Droop of his excavations at Niebla in the province of Huelva, Spain, which raises some interesting points in Spanish prehistory, but lack of space forbids their further consideration here.

Among the contributions to *Ancient Egypt* for December, several are of general interest. Mr. G. W. B. Huntingford has gathered together a number of parallels among modern African peoples for Egyptian customs and practices; Professor Sir Flinders Petrie deals with "Cultivators and Land," a valuable study of the economic, social, and agricultural organization in this department of Egyptian life; and Miss Murray deals with "Royal Inheritances in the XIXth Dynasty." The last-named contribution is a study of the relationship titles of the queens from which the author has drawn some remarkable inferences as to the marriages of the royal princesses, some of whom appear to have contracted mother-and-son or daughter-and-father marriages as well as the more usual brother-and-sister or half-sister unions. The general conclusion that inheritance was in the female line appears to follow almost inevitably as the explanation or justification of the practice.

The Pagan Background of Early Christianity. By W. R. Halliday, B.A., B.Litt. (University Press of Liverpool, Ltd. London: Hodder & Stoughton. 1925. pp. xvi + 334. Price 12*s.* 6*d.* net).

There can be no two opinions about the utility of this book by Professor Halliday. Except for those, comparatively few in number, who have been fortunate enough to be in a position to make a fairly extended study of Greek and Roman history and philosophy, both early and late, the early history of Christianity presents many difficulties which can only be solved by reference to that nexus of political, social and religious ideas and organization which is here comprehended under the term "pagan background." For instance, the rapidity of the spread of Christianity and the universality of its appeal can only be understood in the light of certain facts. Its rise was preceded a little only by the great extension of Roman territory and Roman citizenship under the early Emperors. Within certain limits Rome was both tolerant and eclectic in religious matters; and above all the mystery religions of Greece, and the doctrines of the Stoic philosophers, with their theories of the brotherhood of man, had prepared the way for a great proselytizing religion which aimed at extending beyond a particularist group or people to the whole world. Professor Halliday has no difficulty in showing that a great deal of the so-called "borrowing," which many profess to see in the doctrines and ideas of Pagan and Christian alike, is due to the common intellectual stock and even the common languages of the day. The doctrines of the Stoics already mentioned and the extracts from the writings of Seneca, which Professor Halliday here quotes, furnish numerous instances in point.

Professor Halliday devotes a chapter to the subject of the worship of Mithra which in its history, its doctrine, and its ritual presents so many parallels to Christianity. This worship of a Vedic deity which spread from Persia and eventually, after a syncretism between Mithra and the sun, spread over the whole of the Roman world, was indeed a serious rival to Christianity. Professor Halliday, while accepting as he must the extent of its spread, is inclined to circumscribe its influence. He thinks that in the main it was confined to the soldiers of the legions and that its importance has been exaggerated owing to Professor Cumont's brilliant studies of Mithraic doctrine and ritual. Be this as it may, the ritual of initiation and communion, the baptism in blood, were features common to both religions which did, as a matter of fact, make a strong appeal to the diverse races of the Empire. Yet the early Christians tolerated no trafficking with the mammon of unrighteousness, and it was this very similarity of idea and doctrine which inspired the early fathers in their antagonism to gnosticism and other

forms of esoteric religion prevalent in the early days of the Christian Church.

The interest of the subject has been a temptation to dwell perhaps at too great length on this side of Professor Halliday's work, important as it is. The social, political, and material aspects of the subject are discussed, if not at such length as the religious aspect, at any rate with equal adequacy. Although Professor Halliday has no hesitation in expressing his individual views, it is with due deference to and recognition of authority. His sound scholarship and wide reading make his work a safe guide in a period of many pitfalls and obscurities.

Four Years in the White North. By DONALD B. MACMILLAN. (Medici Society. 17*s.* 6*d.* net).

A long spell of Arctic sojourn presents a rather different picture to that of a hurried expedition to a known objective. The author's book is valuable not simply because he cleared up certain reported but mythical landfalls—the indefinite "Crocker Land" seen by Peary but now found to be a mirage—but because of its description of every form of Arctic condition. For four years MacMillan and his associates studied the Greenland coast and recorded its geography, fauna, flora, and geology. He records the vicissitudes of travel, the joys of hunting and the prowess of those predecessors whose cairns he found. But there is a page in the book which requires rather more expansion than the author has seen fit to give us. A member of the expedition, Green, returns without his Eskimo Pee-a-wah-to, who had been a faithful assistant to Peary for two years. "The story was quickly told," adds the author. "Green, inexperienced in the handling of Eskimos, and failing to understand their motives and temperament, had felt it necessary to shoot his companion. . . . How I hated to tell the mother and the five children that the father was not to return." Nothing more is said, but it leaves one with a queer feeling about the affair. Greenland is not in the Empire, but had the incident taken place on the Canadian side the North-Western Mounted Police do not consider it beyond their work to fetch a man from the Arctic circle, and at least there would have been an inquest or an inquiry. It is to be hoped that the Trustees of the American Museum who are responsible for the expedition have seen to it that adequate funds have been applied to the relief of the widow and orphans.

The most important find by the expedition was a clutch of knots' eggs. This little bird—King Canute's favourite dish—nests in the vast north, but lays a mile or more back of the coastline. The eggs were the first known yet the bird is common to our own shores.

Flower Scent. By F. A. HAMPTON, M.A., B.M. (Dulan & Co. 6*s.* net).

Even a blind man can tell the glory of the rose—although those dreary dogs the modern horticulturists have done their best to rob us of scented roses. Mignonette, clove pinks, all the common old delightful flowers were sweet smelling, yet of late years the scentless bloom has achieved a dealers' notoriety. Of all our senses our sense of smell is perhaps the one we know least about and would least mind losing. Scent is still a mystery, and though much knowledge has been accumulated by perfumers, and in another sense a good deal of rule-of-thumb knowledge by masters of foxhounds, we know very little. Doctor Hampton has done us all a service by producing this little book, for he has brought together a great deal of scattered information, and while eschewing dogma he puts up some interesting suggestions.

You can learn from him how to make your own scents if your garden offers resources. You can ponder the mystery of why a scent in dilution is enchanting but when concentrated absolutely nauseating. Old knowledge rears its head in new guise. Our forefathers used herbs, resins and aromatic oils far more in their pharmacopeia than we do to-day. Yet a concise table shows the antiseptic value of many vegetable essential oils such as thyme and eucalyptus to be greater than that of pure carbolic. There probably was more than superstition at the root of the old doctors' pomander-headed cane or the custom of strewing sweet herbs at the assizes. These herbs may have been useful in discouraging the insects which carry typhus—then known as jail fever. The trees themselves use their resins as antiseptic dressings to heal and prevent infection of a wound.

The author deals concisely with what is known of the chemistry of flower scents, but despite the serious scientific value of the book one feels that he has a greater love for the garden than for the gas cupboard. The book can be heartily recommended to all who enjoy the pleasures of a garden, to botanists, chemists, entomologists, and to the general reader.

Roman London. By GORDON HOME. (Ernest Benn. 15*s.* net).

Londinium must have been rather a jolly place—insanitary perhaps, but even to-day most eastern cities are no better. It is pleasant to think of a gladiatorial show in Southwark, regrettable that now its only contests are between a Labour member—in, and a Liberal opponent—out. Dig down anywhere in the city and you may find Rome. Walls, masonry, road beds, shards of little industries more enduring than the paper and cheap cement structures of to-day. Then there is a compact line of ashes memorial of A.D. 60, when Boadicea raised Britain and demolished the London of that day even more efficiently than applied science can hope to do it when the next war comes.

Mr. Home presents us with a thoroughly readable story of the whole period of Roman London down to the time when the Dark Ages close in and records cease. The outstanding fact is how little we know, how scanty our archaeological knowledge of our city's early history. From the slender clues Mr. Home pieces together a picture of those far-off days which, if not telling us a tithe of what we would like to know, is at least not misleading. The main interest of most readers will centre in those details which tell us of the human interests of those days—the tools of artificers, the knives, pottery and glassware, the sandals and weapons. On page 89 is a block of an instrument which resembles a nutcracker, but whose use is doubtful. An inquiry addressed to a veterinary surgeon might throw light on this point, as it resembles an instrument still used.

A temple to Diana stood somewhere near St. Paul's, and tradition of it endured to the thirteenth century. There were customs officers, fire brigades, and a slave market. We have changed some of our social conditions. Our professed moral outlook is different, our mechanical appliances have changed the scene—yet taking the elements of life there has not been such a very great change since Roman London. The book is delightful to read, and will be welcomed by all interested in their city as well as by the wide range of archaeologists who appreciate good work.

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